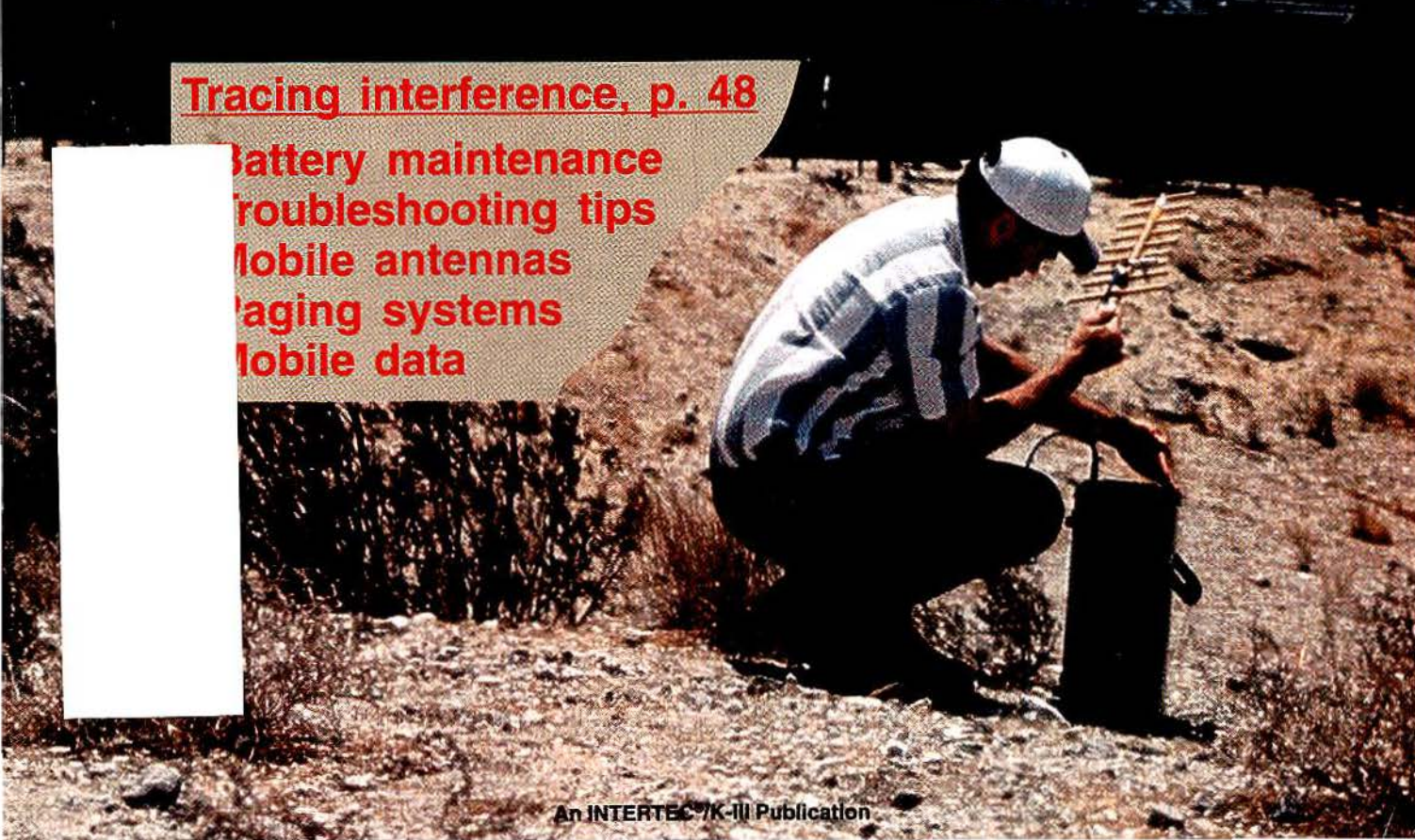
September 1996

Mobile Radio Technology®

Technical information for paging, SMR and private wireless networks

Tracing interference, p. 48

Battery maintenance
Troubleshooting tips
Mobile antennas
Paging systems
Mobile data



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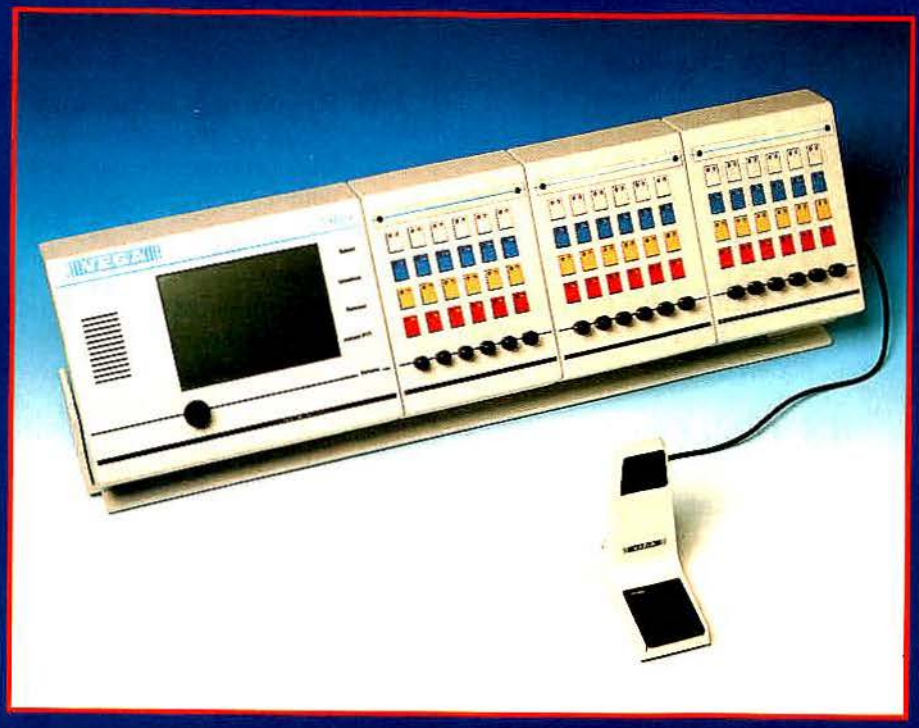

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Scanning . . .

Petition jargon

Used to be, when people filed petitions with the FCC asking the government to change how it allocates radio spectrum and issues licenses, the phrase *public interest* would appear repeatedly.

"Spectrum *X* should be reallocated to do *Y* because it is in the *public interest*. Licenses should be given to *Z* (usually the petitioner) because it is in the *public interest*. Users *A*, *B* and *C* should be required to vacate because it is in the *public interest*.

Why the focus on the *public interest?* Maybe because the FCC is required to regulate for the *public interest, convenience and necessity*. To say *public interest* is shorthand. It used to be the justification for change.

Now, the jargon is the word *consensus*, but the game is the same.

"Use spectrum *X* to do *Y*, give it to *Z*, and make *A*, *B* and *C* vacate because ... well ... all of us who are signing this here petition have reached a *consensus*. We not only have our own *consensus*, but we think it represents an industry *consensus*."

These days, the FCC likes a *consensus*, and maybe if we say *consensus* enough, it will think we have one.

The latest to file a *consensus* petition (maybe pioneers to use the new jargon ... we're not sure) are AMTA, PCIA, SMR WON and Nextel.*

"We have been in this fight a long time," said Alicia Clemens, SMR WON's executive director. "We are weary, but we have realized a great victory in the fact that we have done what the FCC asked us—the industry has drafted a solution to a complicated problem. We urge the FCC to join us and move ahead."

The consensus plan is based on an assumption that local operators throughout an Economic Area (EA) can come together to negotiate a relocation plan with Nextel that would result in the local operators' jointly holding an EA-wide license for the channels swapped by Nextel.

No good, says SBT.† The plan has been opposed by SBT as unworkable; not designed to cure spectrum warehousing problems that still plague the industry; not responsive to the actual service area of existing systems; and based on a presumption that operators must join or be punished for their independence.

"We can discern no benefit which local operators will achieve through the plan that will provide additional opportunity or competitiveness," said SBT president Lonnie Danchik. "Besides, nothing in the plan seeks to reverse the past abuses by certain large carriers in gathering channels for no legitimate purpose. Instead, the plan merely glosses over past wrongs to give the illusion of progress. Our members deserve more than placebos."

Not exactly a consensus, this consensus.

* * *

UHF-TV reallocation

Perhaps not many people outside of the private radio industry (soon to be commercial mobile radio industry) care about the FCC's efforts to displace small businesses that offer wireless communications services in the 800/900MHz band. These service providers support other businesses that are their customers. Where better for the government to establish the precedent of halting the growth of small businesses and then removing them in favor of large service providers than where opposition tends to be fragmented?

Now the broadcasters are feeling the heat, as FCC Chairman Reed Hundt speaks of a proposal to reallocate as much as 60MHz of radio spectrum, taking it away from TV broadcasters that use channels 60–69, and giving it over to other services, including mobile communications. The idea is to reassign these upper-channel TV stations to other channels within the range of channels 2–59.

Foremost, broadcasters detest losing spectrum. Moreover, lower channels are considered more valuable. What station on channel 65 wouldn't want to move to, say, channel 5, if it could? Among TV broadcasters, those with VHF (channels 2–13) licenses would hate to see competitors with UHF licenses (channels 14–69) improve their lot by moving into the lower band, which often has considerably better coverage.

Repacking several UHF stations into the VHF band would make it more difficult for the FCC to clear the VHF band at a later date for mobile services, relocating every VHF station to the UHF band. That step was discussed as a possible outcome—10 or 15 years or more in the future—of TV stations' adding digital, advanced TV services on UHF channels. Perhaps merely reallocating channels 60–69 is enough to sabotage a future clearing of the VHF-TV band.

Say, could that be part of the reason for moving the UHF stations? Broadcasters. They're wily. And mostly united. There will be some infighting about moving the UHF stations. But the result just might give them a lock on VHF spectrum that otherwise is considered nearly ideal for many mobile services.

Maybe the FCC isn't really giving the broadcasters heat when it talks about repacking the TV channels. Maybe it's another warm hug!

* * *

Spectrum wall chart

The National Telecommunications and Information Administration, an agency of the U.S. Department of Commerce, has issued a wall chart defining spectrum uses from 3kHz to 300GHz. If you would like to obtain a copy, here's how:

The product name is "1996 Spectrum Wall Chart"; the stock number is 003-000-00652-2; and the price is $3.25.

Orders can be placed by mail to "U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954."

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—Don Bishop

*American Mobile Telecommunications Association, Washington, DC; Personal Communications Industry Association, Alexandria, VA; Specialized Mobile Radio Wireless Operators Network, Greenwood, MS; Nextel Communications, McLean, VA.

†Small Business in Telecommunications, Washington, DC.

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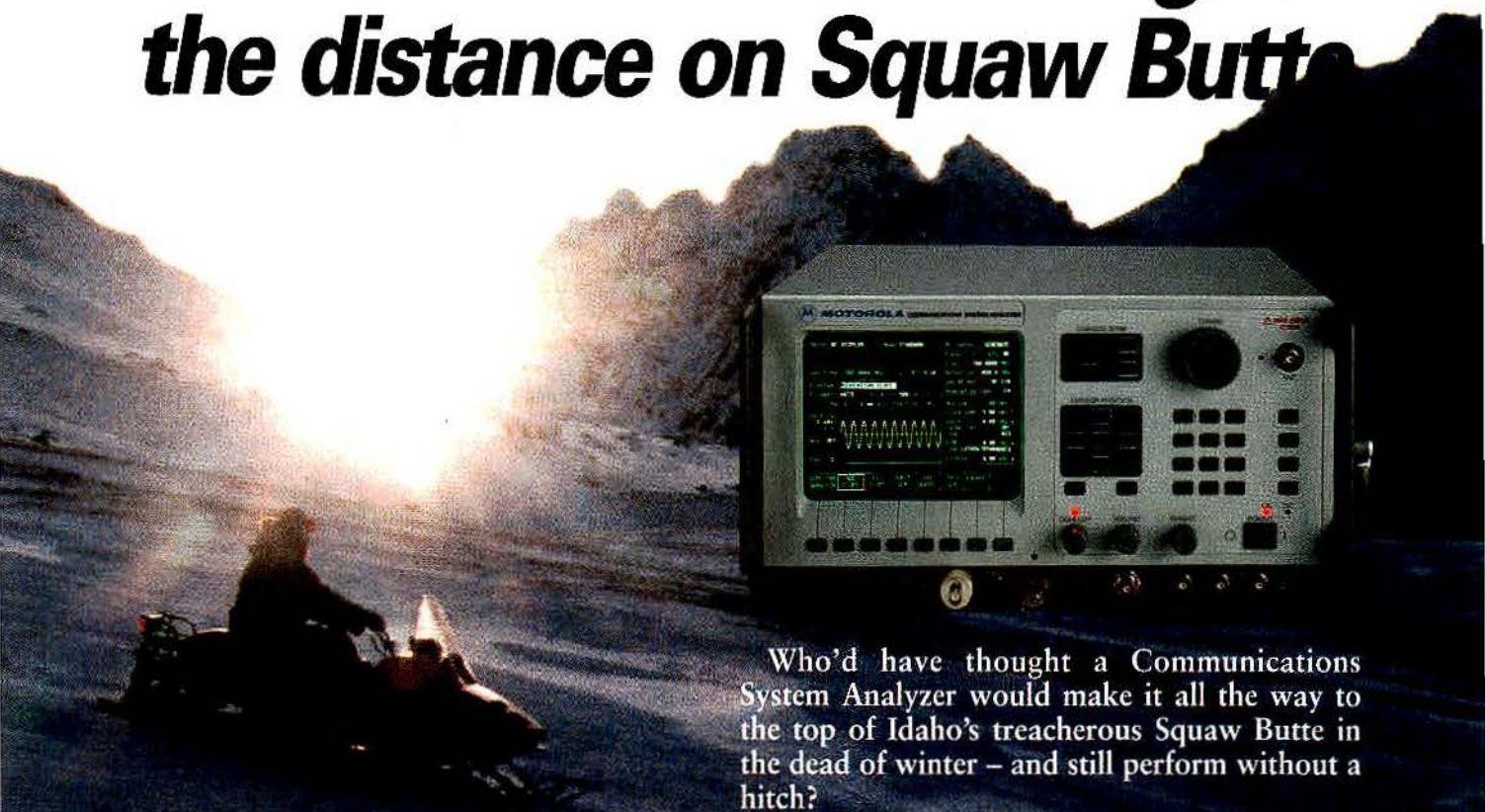

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Calendar

September

16–17—Pre-PCS CDMA workshop on CDMA System Design, Engineering and Optimization, sponsored by Wireless Institute of Technology, San Francisco, CA. Contact: 510-490-6459; E-mail wit@freemark.com.

19–21—Personal Communications Showcase, sponsored by the Personal Communications Industry Association, Moscone Convention Center, San Francisco. Contact: 800-326-8638.

24–27—Satellite Communications Expo & Conference, sponsored by *Satellite Communications* magazine, Sheraton Washington Hotel, Washington, DC. Contact: 303-220-0600 for information on attending and 770-618-0423 for information on exhibiting.

October

7–9—Wireless Apps, sponsored by the Cellular Telecommunications Industry Association, Bally's, Las Vegas, NV. Contact: 301-694-5243.

30–Nov. 1—WirelessWorld Conference and Exposition, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Orange County Convention/Civic Center, Orlando, FL. Contact: Susan Link, 913-967-1969.

November

22—Radio Club of America, Communications Symposium, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Gerri Hopkins, 908-842-5070.

18–19—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.

18–20—First International Congress on Commercial Trunked Radio, sponsored by the International Mobile Telecommunications Association, Intercontinental Hotel, Miami. Contact: 202-331-7773.

1997

March

3–5—Wireless, sponsored by the Cellular Telecommunications Industry Association, Moscone Convention Center, San Francisco. Contact: 202-785-0081.

23–26—Energy Telecommunications and Electrical Association, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.

April

22–24—International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-288-8606.

May

5–7—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix, AZ. Contact: Wendy Rochelle, 908-562-3870; Fax 908-981-1769.

June

2–5—Supercomm, sponsored by USTA and TIA, New Orleans Convention Center, New Orleans. Contact: 202-326-7300.

16–20—UTC National Conference & Exhibition, sponsored by UTC, The Telecommunications Association, Oregon Convention Center and Red Lion Lloyd, Holiday Inn, and Travelodge Hotels, Portland, OR. Contact: 202-872-0030.

September

10-12—Personal Communications Showcase, sponsored by the Personal Communications Industry Association, Dallas Convention Center, Dallas. Contact 800-326-8638.

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Technical information for paging, SMR and private wireless networks

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Troubleshooting techniques 101

By Harold Kinley, C.E.T.

Over the years the requirements of a land mobile radio technician have changed considerably. In spite of all the changes, one thing still separates the "men from the boys"—the troubleshooting ability of the technician, not age or experience. Of course, age and experience certainly tend to enhance the ability of the seasoned technician, but one must have the potential to begin.

You have probably seen "technicians" come and go who could never seem to properly diagnose problems effectively. The "hunt and miss" techniques they used just didn't cut it in the busy land mobile radio shop where turning out work on a timely basis is survival.

There is no single "right" way to troubleshoot a given piece of communication equipment. Two technicians, given the same arsenal of test equipment, may proceed differently in troubleshooting the same problem. The best method would be the one that leads to the fastest repair of the malfunctioning equipment. In this series we will look at some of the proven methods of troubleshooting that have evolved over the years, and some of the unorthodox methods as well.

The workbench

To troubleshoot efficiently, the workbench must be properly organized and equipped. The workbench should have all the test equipment that is commonly used in troubleshooting land mobile equipment. The equipment should be within easy reach from the technician's normal working position. The center piece of the equipment arsenal is the *service monitor*. The service monitor normally contains virtually all of the basic test equipment requirements in an integrated package for convenience and accessibility. Other test equipment should include a high-quality bench power supply with voltage and current metering, including adjustable foldback-current-limiting to protect both the supply and the equipment under test.

The workbench should provide sufficient space to place the service manual without taking up all the needed work space. The workbench should be kept uncluttered and should be cleaned between each service job. A cluttered workbench leads to confusion, resulting in inefficiency and, thus, longer service time. A complete set of interconnecting test cables should be nearby and kept in good repair. A bad or intermittent test cable can send the best technician on an occasional wild goose chase!

Of course, good lighting is a must. In addition, a lighted magnifier should be attached to the workbench. The age of microminiaturization necessitates this. Sometimes, a fluorescent light fixture can generate lots of noise, which may interfere with receiver sensitivity tests. Still, fluorescent lighting is desired—just make sure the lighting isn't causing noise to appear in the receiver.

Talk to the customer

The way a customer describes a problem may be confusing, and the technician should make an effort to confirm weird complaints. Remember, the customer is not familiar with technical terms and may describe a problem in an unusual manner. Quiz the customer until you gain an understanding of the problem. It may be a case of the customer not operating the equipment properly.

The equipment should be removed to the workbench only when it is determined that the problem does not lie in the installation or improper operation. Once the equipment is on the workbench, all complaints should be verified through *external* test and measurement procedures.

Confirming the symptoms

When faced with a malfunctioning piece of equipment, often the most difficult part of troubleshooting is deciding where to begin. Let the symptoms be your guide.

Suppose you are handed a transceiver, and you are told that the receiver is inoperative. That complaint is not definitive and, therefore, will require some "external" tests to provide a more definitive answer as to what type of problem exists within the receiver.

The logical step is to hook up the transceiver on the test bench and test the controls, such as squelch and volume. Also, when using the ammeter on the bench power supply, check to make sure the transceiver is drawing the proper amount of current. A large current drain in the receive standby mode would indicate a probable short circuit in the transceiver.

Run a sensitivity check on the receiver. Use both the SINAD and the 20dB-quieting method, and compare results with receiver specifications. If the sensitivity is poor with both methods, then one or more stages of the receiver apparently are malfunctioning.

If you cannot *force* a high-level signal through the receiver, it is likely that one of the local oscillators (first or second) is not working (assuming the audio section is working). Usually, unless a local oscillator is dead, you will be able to force a high-level (1,000μV or greater) signal through the receiver. It may not sound good, but you should be able to hear it in the speaker.

Operation of the local oscillator(s) can be determined through the use of a spectrum analyzer with a "sniffer" probe held near the oscillator or mixer. In synthesized receivers, the local oscillator will be a voltage-controlled oscillator (VCO). Some sets are single-conversion—there will be no second oscillator. Crystal oscillator failure is most often caused by a defective crystal. In synthesized sets, if the synthesizer is "out of lock," the entire transceiver usually is disabled by the *lock detector*. An *out-of-lock* condition can be caused by a variety of problems within the synthesizer—missing reference oscillator, missing VCO signal, alignment problems, programmable divider problems and a host of other ills.

To find the defective component(s), troubleshooting must follow some *systematic* procedure. Generally speaking, the trouble must be localized to a *section*. Once the defective section is determined, the trouble is next localized to a *stage*. Then within the stage, the trouble must be localized to the defective *component(s)*. Again, the method used to implement this process may vary from technician to technician; however, there are some general rules that can apply.

Next time we will examine several techniques for signal tracing and signal injection that are used to troubleshoot typical land mobile radio communications gear. We will look at some short cuts that can lead you to a dead or seriously impaired stage quickly.

So, until next time—*stay tuned!*

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

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NPCS technology development advances one-way paging

Although driven by narrowband PCS two-way paging, the interswitch wireless messaging transfer protocol (WMtp) advances one-way paging systems to support E-mail gateways and World Wide Web access.

By Randy Tkatch and Darren Ballegeer

As the next evolutionary step in paging, narrowband personal communications services (NPCS) are attracting a great deal of research and development. NPCS represents the future of the paging industry and its players, and much of the current effort is directed at the voice and data trials that are taking place in selected cities.

In the NPCS technology race, paging carriers and vendors are spending enormous amounts of effort and money on developing next-generation services that will beam us into the wireless future. The NPCS family of advanced voice and data services will provide new conveniences, efficiencies and two-way messaging capabilities.

Conventional one-way paging is part of NPCS, and it will continue to grow at a healthy rate as new NPCS services are launched. In 1995, the number of one-way paging subscribers in the United States grew by 25% to 34 million, and the number is projected to reach nearly 52 million by 2000.* Companies are developing NPCS hardware and applications with this growth in mind. Here is how emerging NPCS technology will advance the performance and functionality of one-way paging.

Networking standards

The current networking standard, Telocator Network Paging Protocol (TNPP), has served the paging industry well for many years. Its limitations, though, are becoming more evident with continued industry growth and the performance demands of NPCS. The latest generation of wireless messaging services require rates of several megabits per second; TNPP can support data rates of only 9,600bps or 19,200bps. The congestion control provided by TNPP also is inadequate; callers may be blocked unnecessarily, or pages may be lost when the network becomes congested during peak hours. In addition, TNPP represents the old style of "send-and-then-wait," which reduces efficiency. A paging terminal must wait for an acknowledgment that can take 0.25 seconds, which is wasted time that could be spent sending more packets.

The only physical connection choices with TNPP are leased-line or dial-up; the protocol does not operate over such media as X.25, *frame relay* or ATM (*asynchronous transfer mode*), except perhaps by the inefficient use of a PAD (*packet assembler/disassembler*). Because TNPP is not used in the data communications industry, the paging industry cannot easily interconnect with certain communications data technologies (e.g., public packet networks or frame relay networks). This lack of connectivity also makes it impossible for service providers to benefit from less-expensive, off-the-shelf hardware and software.

A newly developed inter-switch protocol, WMtp (*wireless messaging transfer protocol*), promises to resolve several deficiencies of the old standard while supporting all the aspects of two-way paging. WMtp is based on TCP/IP (*transmission control protocol/Internet protocol*) switching that is used by many computer networks, including the Internet. With WMtp, service providers are effectively upgrading their internal networks to the same technology level as the Internet.

WMtp provides the fast data rates necessary for voice and data transmissions; 10Mbps and 100Mbps Ethernet (more than 100 times the capacity of today's

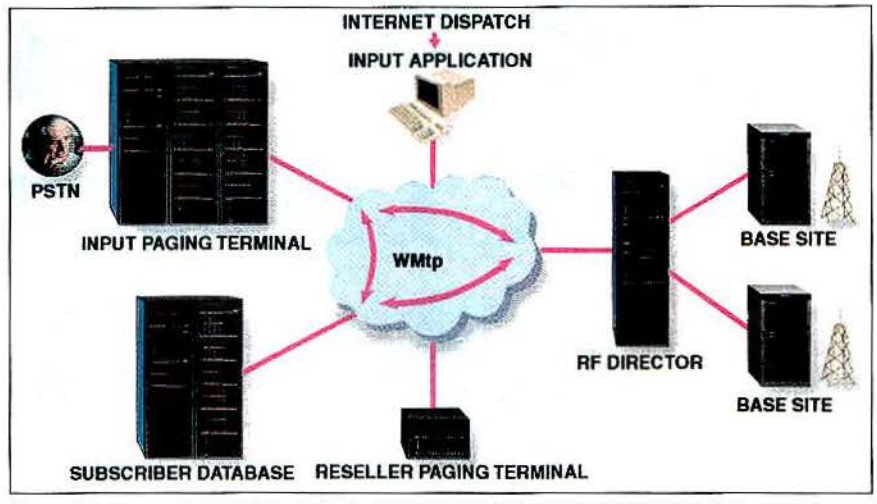

Figure 1. Interconnecting the paging infrastructure elements, the wireless messaging transfer protocol (WMtp) performs all of the one-way paging functions of TNPP and also supports two-way paging.

*MTA-EMCI.

Tkatch is director of networking and applications development, and Ballegeer is marketing specialist, both with the Wireless Messaging Group at Glenayre-Vancouver Operation, Vancouver, British Columbia, Canada.

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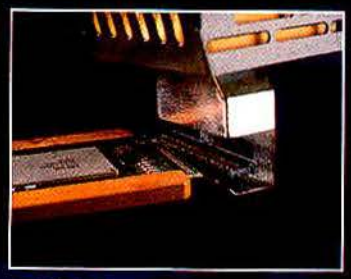

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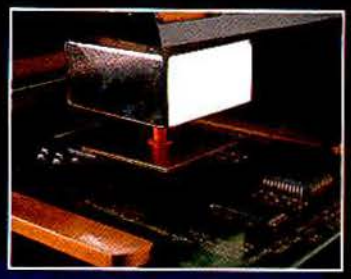

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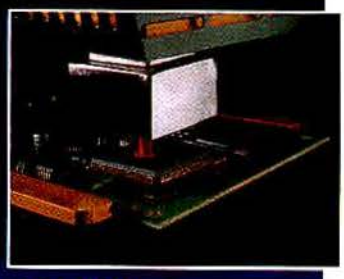

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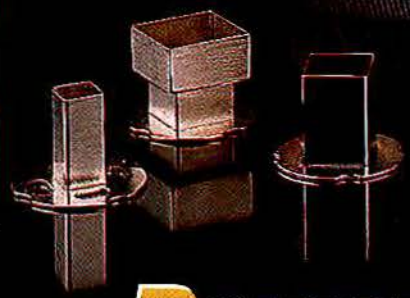

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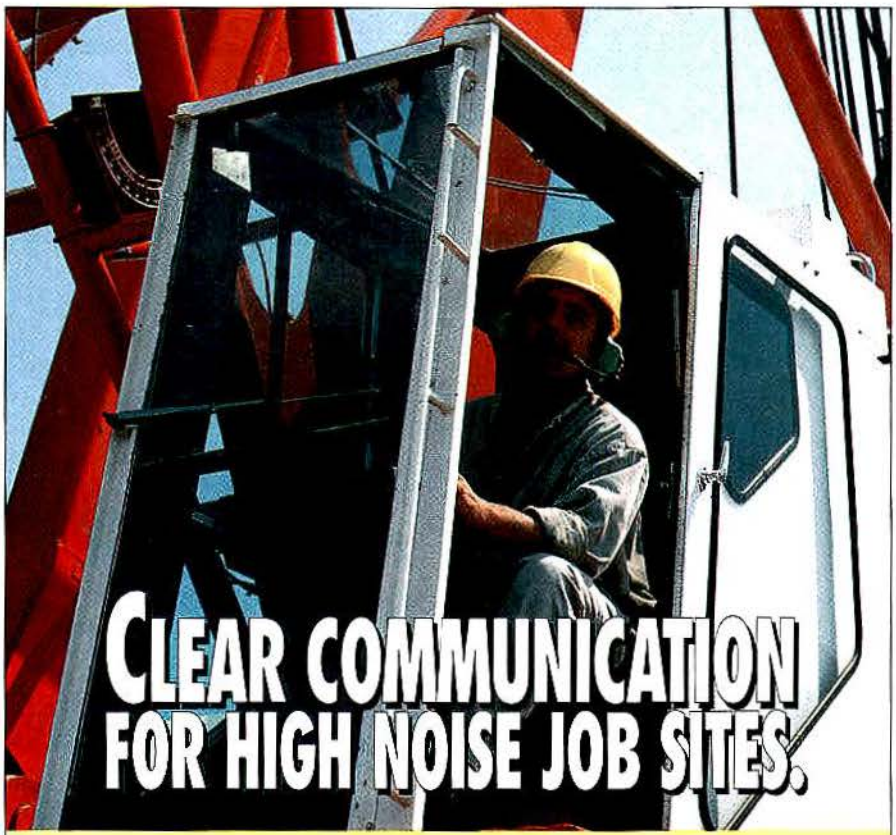
TNPP-based networks). Greater capacity allows more pages per second and the transmission of longer messages. In addition, WMtp's universal support of TCP/IP means that any physical media can be used, including fractional T1, frame relay, X.25 and others. The support of TCP/IP also allows the use of the off-the-shelf routers, network analyzers and network management systems.

Remote encoders are becoming more common because of the use of satellites for connecting paging terminals to base stations. WMtp offers effective congestion control, which is especially needed where remote encoders are used. A remote encoder can detect that a paging channel is becoming overloaded, and it can relay this information back to the input paging terminals so that the flow can be regulated by limiting the number of messages entering the network. For increased efficiency, WMtp goes beyond "send-and-then-wait" by taking advantage of TCP/IP's ability to send many packets while waiting for acknowledgments to earlier packets. Designed as an industry standard by Glenayre, WMtp is easily retrofitted to existing paging terminals by means of a software upgrade and the addition of an Ethernet card. Since its introduction, WMtp has been licensed by Motorola, Ex Machina, Real Time Strategies and TekNow for use in NPCS infrastructure products.



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Throughput

The need to accommodate higher data rates and digitized voice for NPCS is driving infrastructure vendors to increase throughput by using the latest technology. Some examples include:

- faster CPUs.
- faster random-access memory (RAM) and more of it, including cache RAM and local central processing unit (CPU) memory.
- faster and larger disk drivers and faster busses such as SCSI II (small computer system interface).
- intelligent communications cards, with processors and RAM equaling that of the host CPU.

Several vendors are working to make these performance improvements available for one-way paging systems by the end of the year. We believe our company, though, to be the only vendor that has designed these performance enhancements to be available as upgrades to existing paging terminals.

Voice storage and networking

The analog voice pagers of the past were quite inefficient. NPCS technology has made voice paging viable once again. Whereas an analog voice channel may be capable of supporting about 1,500 subscribers, an NPCS system uses cellular frequency reuse, voice compression and high-speed modulation to put tens of thousands of subscribers on one frequency.

How does this apply to one-way paging? Paging terminals today often are used to store voice messages. Subscribers then are notified by a page that a message was received. The subscriber calls to listen to the message.

For service providers, the new technology can reduce the cost of operating a voice messaging network. The hardware and software that are used in NPCS for digital voice paging could be used in one-way paging to compress the stored voice mail messages, thereby offering more efficient storage.

As an example, voice messages often

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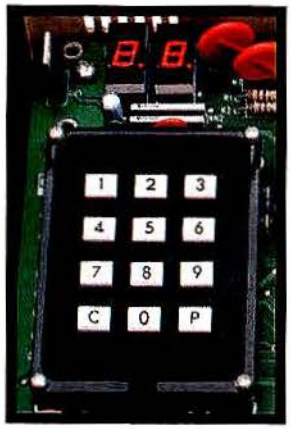

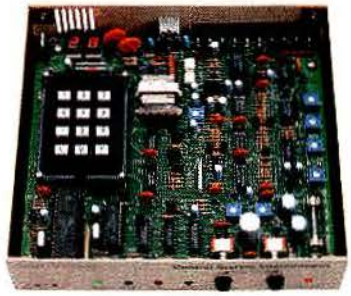

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Options: 1/2 second Electronic Voice Delay, CTCSS operation, Dial click detection, Aux. relay, DTMF, CTCSS, 2 Tone or 5/6 Tone signalling.

MODEL 8200 FULL DUPLEX INTERCONNECT

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Options: CTCSS operation, Dial click detection, Aux. relay, DTMF, CTCSS, 2 Tone or 5/6 Tone signalling.

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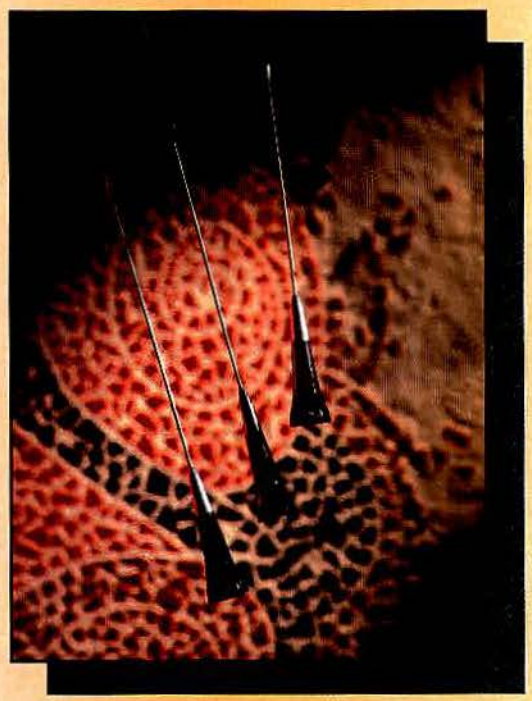

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are stored using 24kbps or 32kbps ADPCM (analog-to-digital pulse-code modulation). High-speed digital signaling processors (DSPs) can use new compression techniques to compress voice down to 8kbps and less. Before NPCS technology, it was impractical or impossible to send voice messages between paging terminals. The new voice compression algorithms and higher-speed networking now make it feasible. Callers can make local calls to a local paging terminal, yet the voice message is kept with the subscriber database record in another terminal. This saves the caller from having to make a long-distance call. Voice networking also makes it possible to build paging terminals without subscriber databases. Carriers can place terminals and subscriber databases where they please, based on the organization of their technical support group and on financial models.

In the drive to make NPCS succeed, carriers and vendors are researching new applications that can use two-way paging technology, including E-mail gateways and World Wide Web access.

In the drive to make NPCS succeed, carriers and vendors are researching new applications that can use two-way paging technology, including E-mail gateways and World Wide Web access. Anyone with an existing E-mail account will be able to send E-mail to a pager and receive responses without any additional software or hardware. Although driven by NPCS, these new applications are perfectly suited to one-way paging. Those who are developing this new technology have carefully considered one-way from the start. NPCS technology is bringing one-way paging and the world of mobile communications to a new level of performance and functionality for service providers and end-users. All of the publicity, effort and money being spent on NPCS does not harm the future of one-way paging. Riding on the latest technology can only ensure its continued growth.

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Battery maintenance made simple

Regular battery maintenance prolongs battery life, keeps the battery fleet in good working condition and provides the user with confidence. Also, fewer batteries are discarded—a direct cost savings.

By Isidor Buchmann

A battery maintenance system under software control services a large battery fleet with minimum supervision. Battery purchase date, prices, vendor references and complete service reports can be accessed through the computer and printed when required.

The need to discharge nickel-cadmium (NiCd) batteries regularly to maintain good performance has concerned users and manufacturers alike. In a desperate attempt to find a maintenance-free battery, some manufacturers went so far as to equip laptop computers and video cameras with the sealed lead-acid (SLA) maintenance-free battery, which proved unsuitable because of its low energy density.

Relief was in sight in the early nineties when the nickel metal hydride (NiMH) battery emerged and was promoted as the recommended choice. Claimed to be maintenance-free, the NiMH is commonly used for cellphones and notebook computers.

With twice the energy density compared to the NiCd, the new lithium-ion (Li-ion) battery is expected to be a popular choice when it becomes readily available. Cost has limited this chemistry to high-end applications, such as notebook computers and specialty video cameras.

Frustrated with high operational cost, poor load characteristics and limited cycle life of the newer battery chemistries, manufacturers are now re-examining the old familiar NiCd, and with good reasons. When properly maintained, the NiCd delivers an impressive 1,500 discharge-charge cycles, a service life three times higher than that of the NiMH or Li-ion. At a cost of only a few pennies per cycle, the NiCd is far more economical to operate than the NiMH or Li-ion. If a NiCd battery fails to provide superior cycle count compared to the other chemistries, lack of exercise is likely the cause.

Table 1—Annual percentage of batteries requiring replacement on the *USS Eisenhower, USS George Washington* and *USS Ponce* as a function of battery maintenance.

Maintenance Method	Annual Percentage of Batteries Requiring Replacement
Charge only (charge-and-use)	45%
Exercise only (discharge to 1V/cell)	15%
Reconditioning (secondary deep discharge)	5%

Battery maintenance

The notion of having to apply regular discharge cycles becomes an acceptable alternative when considering the low operational cost of the NiCd. Because most applications do not use up all energy before recharge, a discharge to 1V per cell (exercise) is essential for the NiCd to prevent the buildup of crystalline formation on the cell plates. Also known as "memory," this phenomenon eventually robs the battery of its ability to hold

Buchmann is founder and president of Cadex Electronics, Burnaby, British Columbia, Canada.

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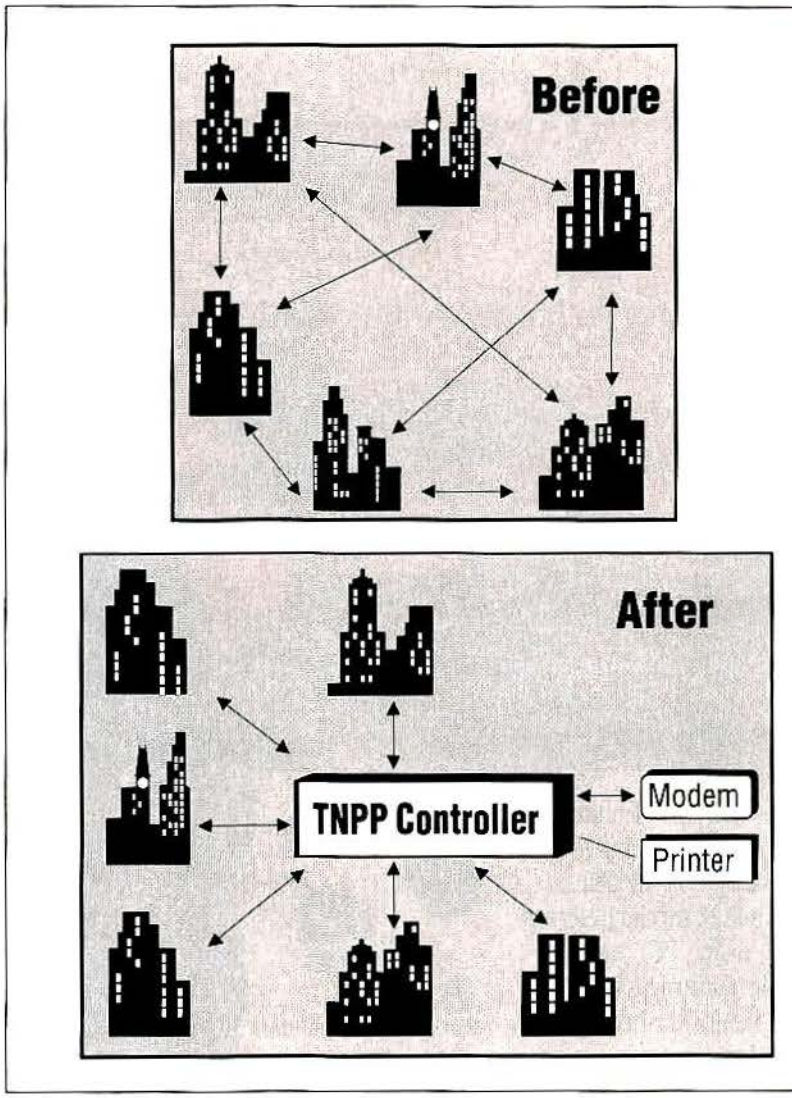

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charge. The capacity loss caused by memory is, to a certain extent, reversible.

If used daily, the NiCd should be exercised once per month. The NiMH is also affected by memory but to a lesser amount—it only needs exercise once every three months. Because of its shorter cycle life, it is not recommended to overexercise the NiMH.

If no exercise is applied for several months, the crystalline formations ingrain themselves, making it more difficult to dissolve. In such a case, exercise is no longer effective in restoring a battery and *recondition* is required. Recondition is a slow, deep discharge that drains the battery of its remaining energy during which the crystalline structure is broken down and the battery is commonly restored.

The importance of *exercise* and *recondition* on NiCd batteries is emphasized by a recent study carried out by GTE Government Systems in Virginia, USA. To determine what percentage of batteries needed replacing within the first year of use, one group of batteries received charge only, another group was exercised and a third group received recondition. The batteries studied were used for portable radios on the aircraft carriers *USS Eisenhower, USS George Washington* and destroyer *USS Ponce*.

Table 1 on page 16 shows a 45% battery failure when *charge only* was used. By applying *exercise*, the failure was reduced to 15%. By far the best results were achieved with *recondition*; the failure rate dropped to a low 5%. The same results were obtained on all three ships.

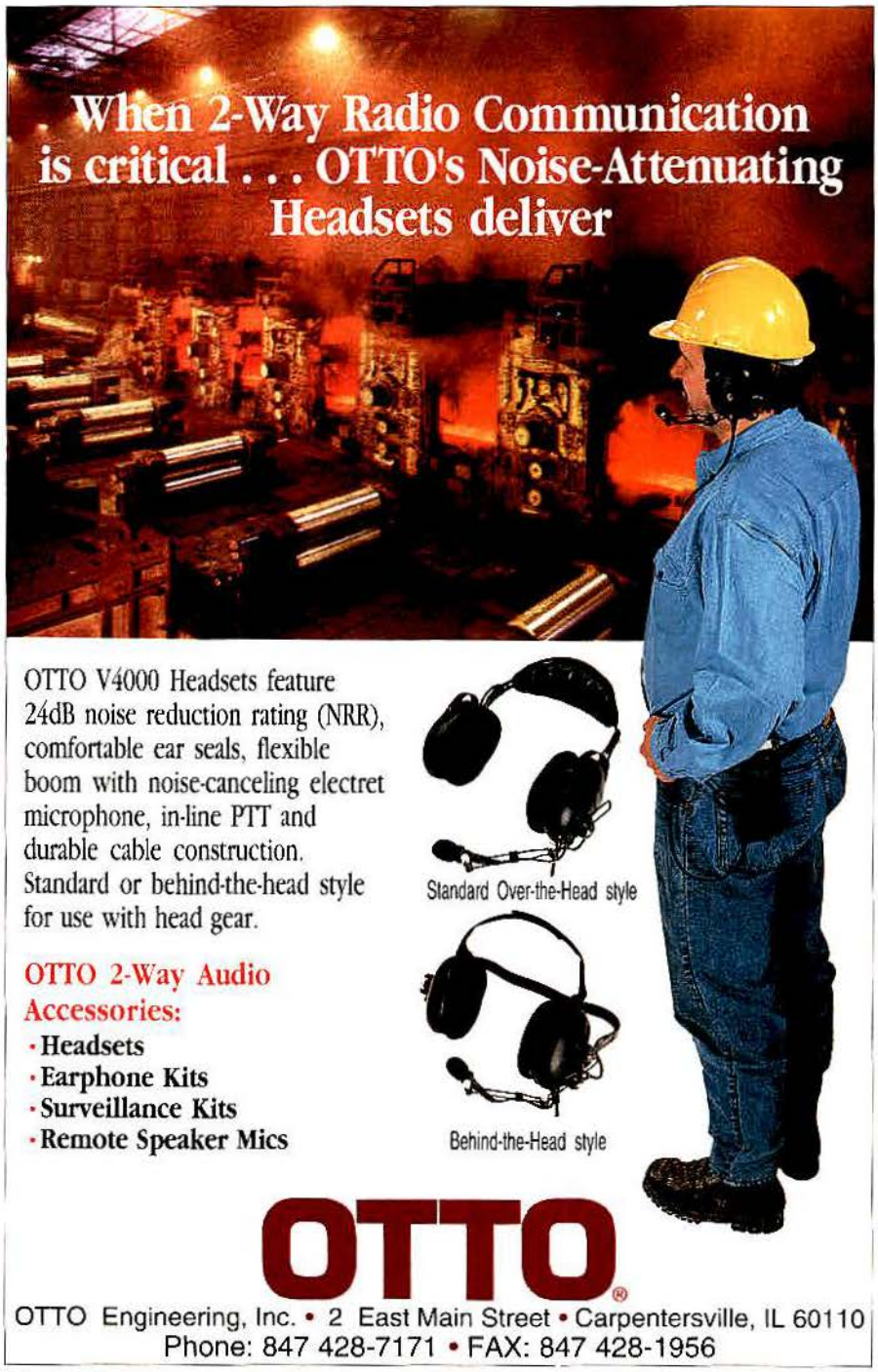
Exercise and recondition are most effective when applied while the batteries are still in reasonably good condition.

The GTE report states further that a $2,500 battery analyzer featuring exercise-and-recondition functions would pay for itself in less than one month on battery savings alone. No mention was made on the benefits of increased system reliability, an issue that is of equal or greater importance.

Exercise and recondition are most effective when applied while the batteries are still in reasonably good condition. Once the crystalline formation has advanced beyond a certain stage, restoration becomes difficult, even with recondition. If restored, a battery with advanced memory may exhibit a high self-discharge, a deficiency that can no longer be corrected. High self-discharge occurs when the spike-like crystalline formation punctures the fragile separator material that insulates the negative and positive plates. By regularly exercising the batteries, the crystalline formation is kept under control, preventing undue damage to the separator.

Battery maintenance system

Any organization using NiCd batteries on a daily routine should set up a battery maintenance system to exercise good batteries, rejuvenate those that fall below a



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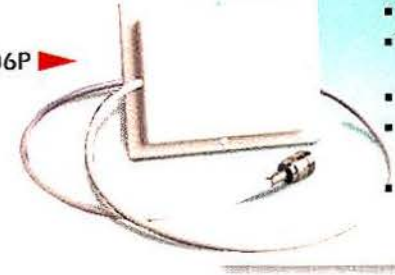

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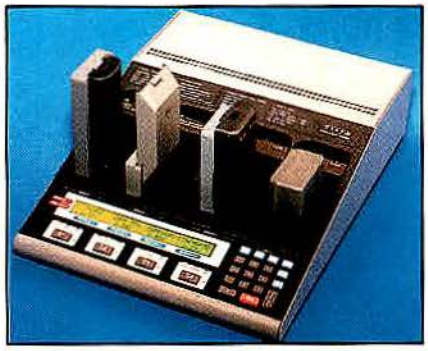

A programmable battery analyzer such as the Cadex 7000 is capable of restoring lost battery performance. The batteries interface through plug-in cups or cables that can be reprogrammed with the analyzer's menu function.

set target capacity and "weed out" the deadwood. Most companies service their batteries either when they no longer hold charge or when the equipment is sent in for repair. As a result, the system becomes unreliable over time, and battery-related failures become frequent. On a routine day, a marginal battery may hold out fine; during an emergency, however, when more energy is required, a poorly performing battery cannot provide the extra power that is needed, and the system subsequently fails.

Implementing a battery maintenance plan requires some effort on behalf of management in sorting the batteries to be serviced and collecting them in one place without disrupting the operation. Certain organizations service the batteries in-house with their own battery analyzers, and others prefer to send them to an independent firm specializing in that service. In both instances, a set of spare batteries will be required to replace those that have been removed.

If the service is done on location and the batteries can be reinstated within 24 hours, only 10 spares in a fleet of 100 batteries are required. If the batteries are sent away, 10 spares are needed for each day they are away. If absent for one week, for example, 70 spares will be needed for a fleet of 100.

After service, the batteries are marked to identify the date of service. One simple method is to attach a color dot, each color indicating the month of service. A different color dot is applied when the battery is reserviced the following month. A numbering system from 1 to 12 identifying the month of service also works well.

Many users prefer to attach a full battery label containing service date and capacity. (See Figure 1 on page 22.) With the label method, a user requiring a battery for a critical mission can examine the state of the battery by simply reading the label. A battery with the highest capacity and the most recent date will undoubtedly be chosen. Battery analyzers are now available that automatically print a label with date, company inscription and battery capacity when the battery is removed.

A key to successful battery maintenance is a good battery analyzer. When first acquiring an analyzer, there is a tendency to buy on price alone. With the requirement of servicing an ever-increasing number of different battery types at higher volumes, second-generation buyers find the features offered on the newer battery analyzers worth the extra cost. The benefits manifest themselves in higher battery recovery, reduced operator time, increased throughput, simpler operation and the use of fewer trained staff members.

One analyzer, for example, evaluates the condition of a battery and applies a

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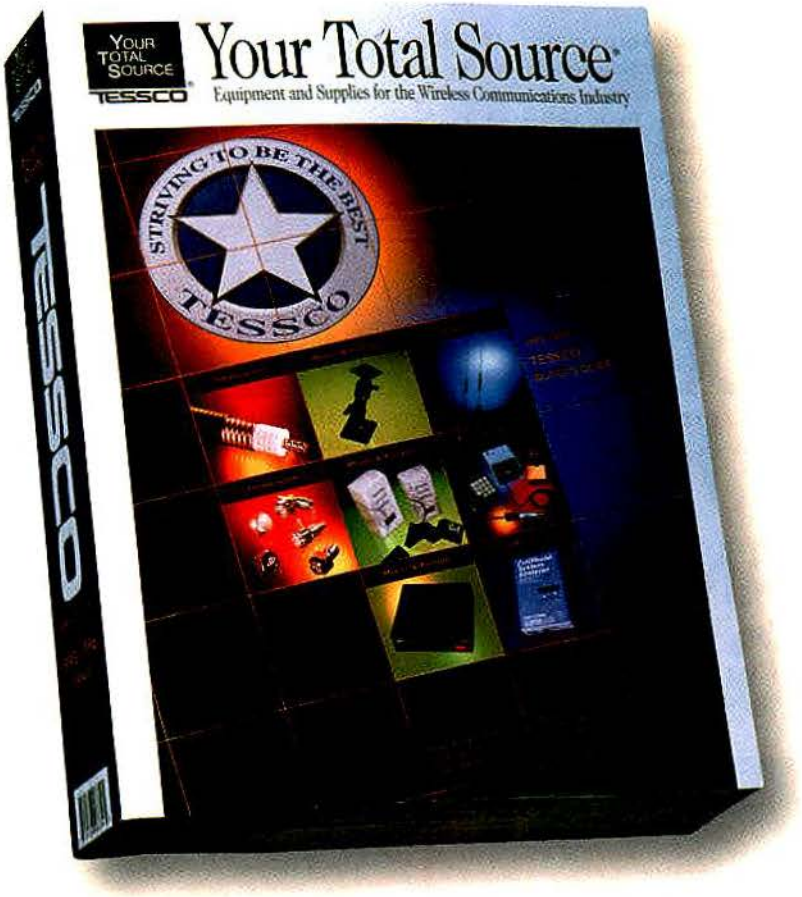

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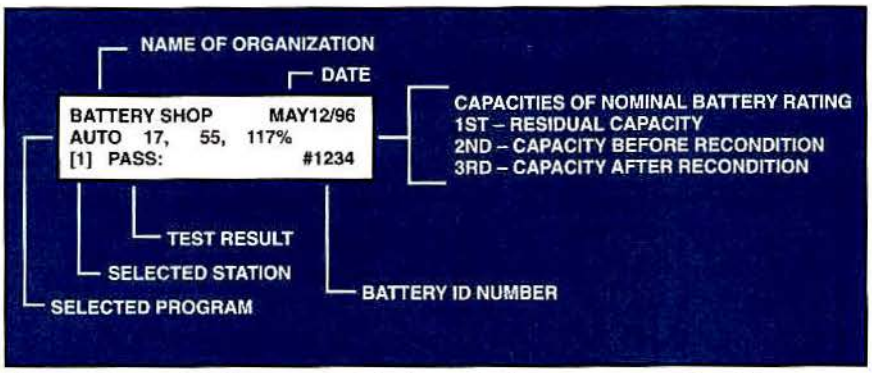

Figure 1. A battery label keeps track of the battery in the same way a service sticker on a car reminds the owner of pending service.

recondition cycle to restore the battery's capacity if a preset performance level cannot be reached. User-programmable switch-mode drivers test the batteries against preset limits, reducing the cycle time by as much as one third compared to fixed-current units. The capacity is displayed in percentage rather than milliampere-hours, freeing the user from memorizing the battery ratings. Each analyzer is capable of processing four batteries every 4–8 hours. Based on two batches per day (morning and evening attendance) and 20 working days per month, one unit is capable of servicing 160 batteries each month. By running an extra shift and increasing the number of working days to 30, the throughput can be doubled.

For larger throughput, Windows-based application software can be used to network as many as 32 analyzers to a host computer. Fully extended, the system is capable of servicing 128 batteries simultaneously.

The software collects battery test results for the database from which inventory status, service reports and graphs are generated. Battery cups and "smart cables" are programmable either through the analyzer's keypad, the computer keyboard or the optional bar code reader. Custom programs and firmware upgrades for the analyzer can be installed through the host computer. Battery ID numbers and battery characteristics (chemistry, voltage, rating) may be printed on bar code labels and attached to the batteries. By reading the bar code labels, the battery to be serviced is identified, and the battery analyzer is automatically configured to the correct limits for the battery intended.

There is a time when a battery must be retired, and the battery maintenance system helps to determine when the time is right.

Conclusion

The requirement for regular battery maintenance cannot be emphasized strongly enough, both in terms of prolonging battery life and in keeping the battery fleet in good working condition. Without any means of measuring the performance of aging batteries, a battery fleet eventually deteriorates to a point where it becomes completely unreliable. For NiCd users, the battery maintenance serves two functions: a) to prevent memory from occurring, and b) to maximize the service life of a battery. Organizations using the battery maintenance method have experienced an increase of battery life by one year and more.

There is a time when a battery must be retired, and the battery maintenance system helps to determine when the time is right. With proper battery maintenance, the number of batteries discarded are fewer, a direct cost savings. More important, well-managed batteries provide the user with a level of confidence that is essential when working with today's hand-held technology.

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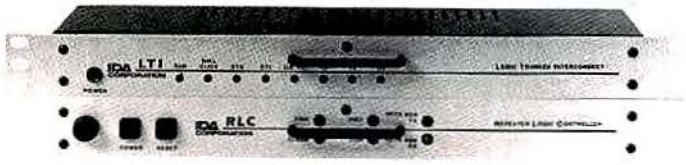

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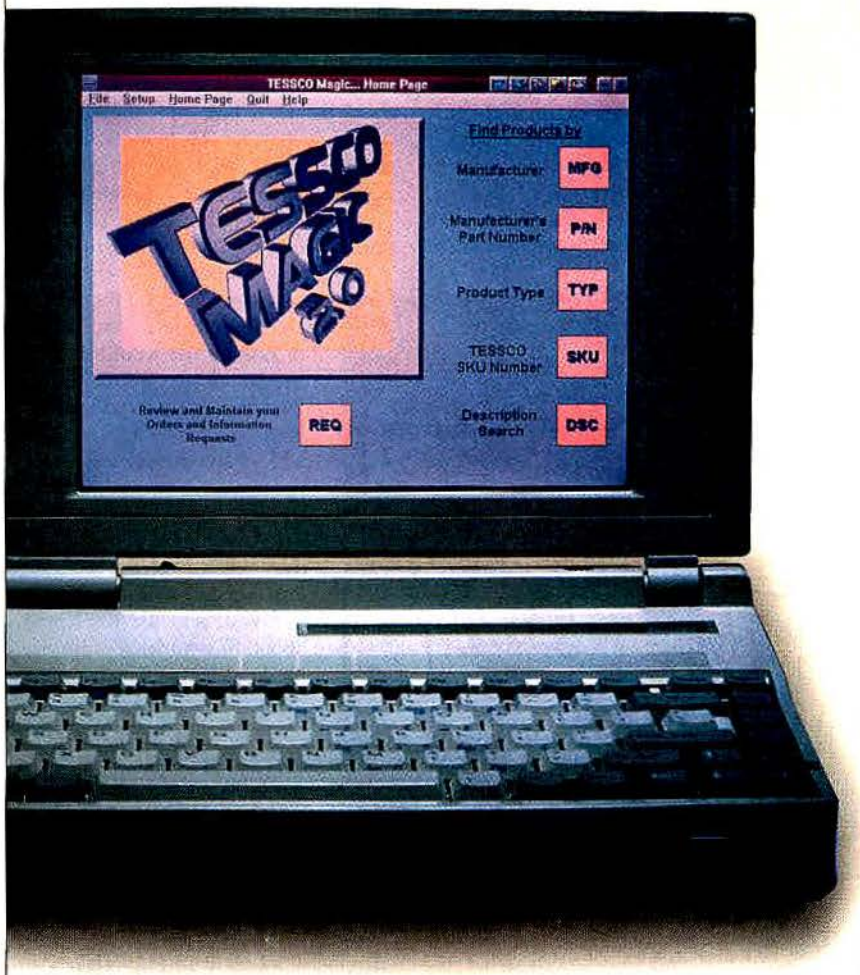

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Pay attention

Manufacturers develop special tools to avoid potential equipment adjustment and component installation problems. Remembering which tools and techniques to use speeds servicing procedures.

By Walter Rheingans

The shop staff was finishing the monthly inventory and preparing to get going on real work. Housekeeping, bookkeeping and inventory never seem like real work. It is getting a lot easier now that Motorola, Ericsson and others have on-line parts ordering. The use of PCs really seems to be helping small businesses like ours increase efficiency. We are working with no clerical staff at all, yet we're finding it normal to have volumes of data and help at our fingertips. Isn't life great!

"I think we have enough of the fast-turnover antennas and batteries," concluded Ruben. "What about the front-mount VHF and UHF radios?"

"Plenty for next month," I decided. "Doesn't it look a little slow for this time of year? We haven't seen any reason to stock higher, and we can get a quick shipment."

"Finished the critical customer repair stock check," added Karen.

"Me too," Jerry said. "I'm done with the miscellaneous parts."

Our habit is to maintain three categories of stocking. For critical customers, such as the sheriff, we have some on-the-shelf spares for things such as voter modules, control cards and similar items. The sheriff cannot wait even for two-day delivery for repair components on some parts of his critical dispatch system. This extra inventory is reflected in the monthly contract charge to the sheriff.

Next, the fast-turnover stock. We keep this at a high level because if it is not on hand, the sale will be lost. Last is routine parts, small odds and ends: resistors, installation hardware and fuses. The small stuff is hard to keep track of. However, it does have a convenience and efficiency value far in excess of its cost. We keep it well stocked, really in depth. Most other parts and modules the manufacturers can deliver, on-demand, in a day or two.

"What's scheduled for today?" I asked.

"Karen and Jerry have a rechannel job for the water company," replied Ruben.

"The water company received 15 surplus Motorola MT-500 hand-helds from its regional center, and they want them recrystalled to the local channel."

Is that going to be cost-effective?" I asked.

"Sure. Three weeks ago, Karen and Jer pulled the old channel elements, and I sent them to Bomar," Ruben replied, "and they came back a couple of days ago. Didn't cost much. Both the old and the new frequencies are close together so it shouldn't take long to finish. No retuning is needed."

"Where's the box from Bomar?" Jerry queried. "Karen and I want to get started. This housework is driving me nuts."

"Me too," Karen added.

"Here you go," replied Ruben, handing them the UPS box with the channel elements in it. "Do you know where to find the instruction book for the MT-500?"

"We can handle it," Karen said.

With box in hand, Karen and Jerry set up a strategy. They decided to make it a production line operation. Jerry would open the units, install the channel elements and hand them to Karen. She would then set the frequency and check the modulation. Karen would then pass them back to Jerry, who would add a battery and close it up. The batteries had all been run through the Alexander Batteries Tri-Analyzer and reconditioned over the last week. Only one battery needed replacement.

"Well, Jer," started Karen, "at about 10 minutes a radio, we can be done before lunch time if we push it.

"OK," answered Jerry, "let's give it a go!"

"When you pull them apart, watch for bad gaskets and screws. We have a box of spare parts we can use. If you jam the screws, it really makes a mess," Karen said.

"Gotcha," said Jerry.

Everything was ticking like a clock factory as Karen and Jerry's mini-production line worked through the morning. About half-past eleven, Ruben checked on them. He thought it was a smooth operation and brought a couple of the radios up front to show the boss.

"Well, Wes, they are going great guns on these radios," announced Ruben. "They'll soon be done. Looks pretty good, huh?"

Rheingans is a free-lance writer in San Luis Obispo, CA.

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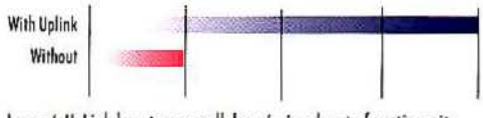

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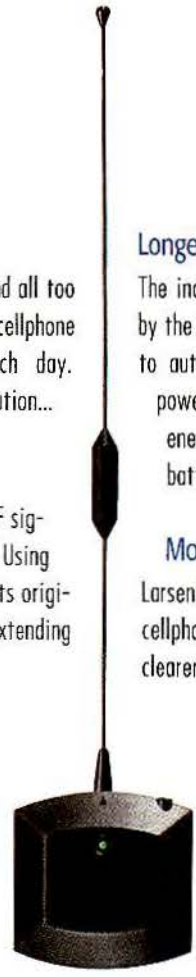

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"Sure look like new." I answered. "Real clean."

"Jerry is cleaning the outside as he reassembles them," Ruben said.

"Let's try one," I said, turning it on. "Water One, this is radio repair for a radio check. How do you copy?"

"I always want to call them Wet One," quipped Ruben as we awaited an answer.

"'Buzz'...'buzz'" came a distorted reply, with the copy broken and scratchy.

"Thanks, Radio Repair clear." I said. "Well, Ruben whatcha think?"

"I think we better double-check the task at hand," he replied.

Ruben and I went to a bench and set up an IFR service monitor. Connecting an adapter into the MT-500 and punching in the channel, we took a look at the radio. We found good modulation, but the frequency was about 2kHz off center. We tried another radio, and found the readings about the same. Another checked likewise.

"Karen," I asked, "is your IFR set off the calibrate click?"

"Why do you ask, Wes?" Karen answered. "Is something wrong?"

"Yup. "

"Let's check some more of them," Ruben suggested.

"All of 'em," I replied.

"My IFR settings check," Karen said. "What's wrong?"

"These radios are all off-frequency. That's what. We need to figure out why," I continued, "and fix it. I did a radio check with Water One, and they said it was scratchy, so Ruben and I checked on the other IFR, and the frequency was off a couple of kilohertz. Two more checked the same."

"Ouch," winced Karen. "I have been very careful when I set the frequency."

"Are you using the faux back?" I asked.

"What's the fall back?" Karen and Jerry asked, in stereo.

"Not *fall* back, but the French f-a-u-x, pronounced 'foh.' *Faux* means false. We have an MT-500 cover set with holes in it so you can set the frequency with the covers on.

"Well—in a word—no." Karen meekly replied. "Now I remember. We went over that at a Motorola seminar once. The MT-500 can shift frequency when you close it up and tighten down the assembly. When that happens, the cure is to use a 'jig', or as you call it, the faux back, to make sure the frequency is correctly set. It takes just a little more time, but it always works. Every time."

"That's the one," I replied.

"Looks like I committed a faux pas, huh," Karen joked.

"Yup," I groaned, "but if you notice, the radios were all about the same. Here's the cover set, and you can get them done real quickly. Modulation is OK, just set the frequency."

"OK," answered Karen.

"Wait!" called out Jerry. "While you were explaining the error of our ways, I was looking into another problem. Some of these radios seem to be intermittent. I can't get a handle on it, but it seems the crystal elements don't fit tightly every time. What do we do, send them back?"

"No, there is a simple fix," answered Ruben. "Karen, do you remember any more from that old seminar?"

"You mean the squasher?" Karen replied.

"Yes," said Ruben, "the squasher."

"Geez, you guys are talking about faux backs and squashers," interrupted Jerry, "but don't we have any normal

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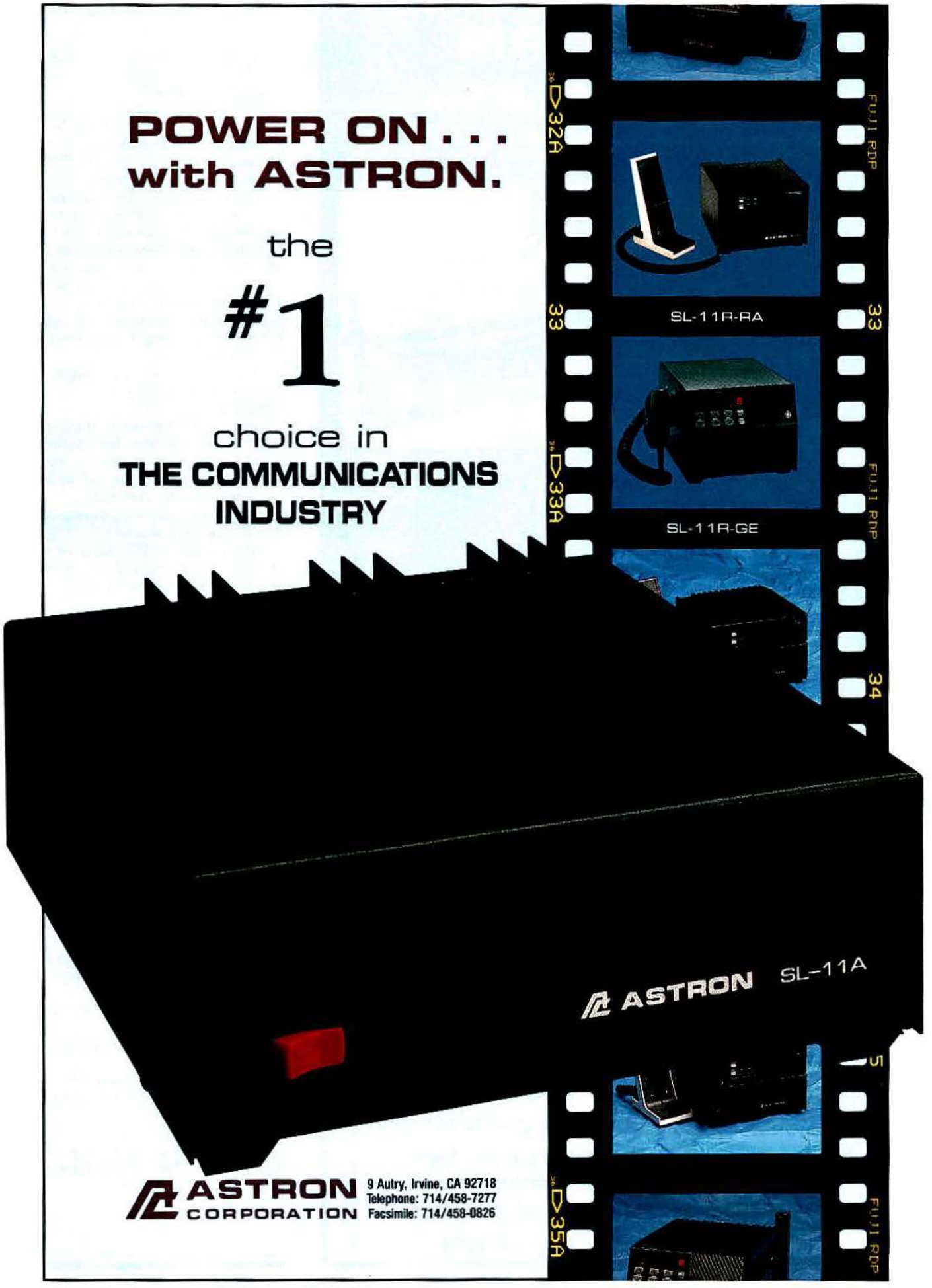

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American solutions?"

"The squasher is all-American, Jerry," I said. "Baseball, apple pie and Motorola tools are as American as you can get. The channel elements in the MT-500 were designed to fit into little pin sockets. To ensure a reliable fit, Motorola engineered the pin on the channel element to be squashable by making it from many strands of stiff, gold-plated wire. Then they put a bulge in it to make it fit tight in the socket. For maintaining this good fit, they engineered a squasher tool. Here is a pair, with green handles. It looks like pliers, with a groove on one lip and a hole on the other."

"I saw those on your bench, but I had no idea what they were for," Jerry admitted.

"Just put the groove against the little lip at the base of the channel element," Ruben said. "Insert the tip of the wire into the hole on the other lip, and squeeze."

I picked up the explanation. "It has a stop to keep you from destroying the pin. It just 'squashes' it a bit."

"This squash," added Ruben, "is all that is needed to maintain good contact and eliminate intermittent channel element operation."

With new instructions, Jerry and Karen returned to the task of getting the radios finished. Jerry went back and re-opened every one of them. He then "squashed" the pins on each channel element, just to be safe. Karen, at the next work station, took the units and clamped down the faux covers and reset the frequency. It went smoothly, and in no time they were finishing the task. Of course by now the clock was ticking into their lunch break.

"Hey, Wes and Ruben," hollered Jerry. "Karen and I are finished, but will you double-check for us?"

"Yeah," added Karen, "things can happen, you know."

"No problems," Ruben replied, as he set up a check and ran through five of the units in a flash.

"Watcha say, Ruben," I asked, "do these guys live or die? What's the verdict?"

"Thumbs up!" smiled Ruben. "You got it this time."

"So, did you all learn anything this morning?" I asked.

"Sure, pay attention to what you know," Karen chanted, "and to the details. Pay attention! Pay attention!"

"And you Jer?" I asked.

"I learned that if you don't get it right the first time," Jerry stated, "you'll have a short lunch break. Let's eat!"

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Mobile data: A realistic view

Software is the key to a mobile data system. The hardware and radio frequency (RF) link only facilitate the software. Define the customer need, select the software and match it with the necessary hardware and radio equipment.

By Ted J. Schaefer

Mobile data: The two most hyped words in the last 10 years since *cellular phones*. It seems as though everyone is on the mobile data bandwagon, yet there seems to be a real lack of knowledge and a mystique about mobile data. Mobile data covers a wide range of applications. In its simplest form, mobile data is a "text"-based or "digital" form of communications. Digital, in this context, is not to be confused with digital signaling, but a digital or text-displayed format instead of voice.

The earliest introduction of widely used mobile data could be considered the display or "digital" pager. The dominant format of pagers has shifted first from "tone-only" to "tone-and-voice" to either numeric or alphanumeric display. Other common forms of data communications include fax, E-mail, wireless computing via cellular or radio, wireless telemetry, and supervisory communications and data acquisition (SCADA). Mobile data can take any of these forms or more, but it does mean "on the go, mobile" as opposed to fixed, point-to-point communications.

The components of a mobile data system can be broken down into three major parts.

1. *Hardware* — This includes the display or interface device, the modems to send and receive the data, base controllers to manage the data and the associated cables.

2. *RF link* — The RF link, or RF pipe, as it is known, informally, is the wireless medium you choose for your customer to transport the appropriate data. This would include cellular phone service, private and public radio systems, satellite, spread-spectrum and many other types of wireless service.

3. *Software* — This includes the communication drivers for the modems to talk to each other, the program the controller uses to manage the data, any interface software to a host computer system, the application the field user sees, the program the dispatcher may see and many other areas where software comes into play.

Make no mistake, mobile data is a software solution to a hardware problem. Voice communications can be too slow, unreliable and even inappropriate for the transmission of most mobile data applications. Available spectrum is a real problem in most markets today. Mobile data, conversely, is fast, reliable and secure, and can provide unattended communications.

It seems as though everyone is on the mobile data bandwagon, yet there seems to be a real lack of knowledge and a mystique about mobile data.

The key to designing and selling a mobile data system begins with the software. The hardware and the RF link are there only to facilitate the software. Certainly, all the component parts, properly in sync with each other, are necessary for a satisfied customer. Contrary to the hopes of some hardware manufacturers, just building the hardware does not mean that customers will buy it. Pen-based computers are a good example.

A well-designed mobile data system starts with the application. Starting at that point means asking the customer what use they have for their radios or phones now, if they have them. "What type of data is coming and going via voice communications?" you might ask. "Why do you page your fleet vehicle drivers? What does your paperwork load look like? How do you do business?" The answers to these and other questions help to get a clear picture of how a customer does business and, ultimately, how mobile data can help. This process, when done in depth and in great detail, draws the road map to the mobile data system.

A basic knowledge of the types of mobile data systems is important for the interviewer. Without the proper foundation of mobile data systems or the components, the interviewer may not ask the right questions. Leaving aside the obvious systems of fax, E-mail, digital paging and file transfer, let us look at the more advanced systems.

Status and message

In one of its simplest forms, a mobile data system could be used to replace a radio system and to convert the current voice messages to text messages displayed on a screen at both ends. Status-and-message terminals generally require the driver to push only one or two buttons to alert dispatch of a status change. The actual status depends on the business and what the dispatcher wants to know, and status information usually is repetitive. In addition, some systems allow the driver to enter some limited variable information that could be used for tracking mileage, job numbers, weight and hours. The dispatcher, on the other hand, might see a message or graphic to signify the new status of the driver on a computer screen. Some systems keep this status on the screen for future reference and change the

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display when the driver sends an updated signal.

Status notification over radio, a one-way transmission from the field unit, has been in use for many years. Newer two-way units allow messages to be transmitted back to the driver. This could be signaling lights to tell the driver about the next stop or text messages, either pre-written (canned) or free-hand. Most systems make provision in the vehicle's data terminal to receive a message whether the driver is present or not, thereby speeding up the process. Most systems also acknowledge the receipt of the message or status to avoid the need for *retrying*, or sending the message again and again until the driver responds.

The real advantage to this type of system is that it lets the dispatcher deal with repetitive information quickly, almost casually, because it is the exceptions that require attention. Units that remain in a certain status too long or that have gone out of sequence, or drivers who indicate that they are lost or that their jobs have been cancelled, involve situations that may require special attention. It is the repetitive, non-exceptional voice communications that take up most of the time and effort and do not allow for sufficient attention to exceptions. As much as 85% of the communications between the office and field personnel are routine or repetitive. This type of information is best suited to mobile data instead of voice radio.

There are several good status and message systems on the market. Each puts a different spin on driver interface, dispatcher display units, pricing, size and options. These systems typically are standalone and usually are not integrated into larger business applications systems. If integration is necessary, special care is required.

Circle (24) on Fast Fact Card

Automated dispatch

Automated dispatch represents a quantum jump in equipment, dollars and application. In a status-and-message system, the dispatcher sends a limited amount of information to the driver, and the driver sends his status and, perhaps, some variable data. An automated dispatch system generally encompasses much more. This system can take the shape of a complete customer service package providing for service call-taking, creating service orders, transmitting service orders to field technicians and more. Some systems maintain a screen display listing of the day's customers and let the dispatcher assign service orders to technicians as they become available.

Technicians, on the other hand, may have the ability to update, charge and close out a completed service order. Some systems provide for on-truck inventory maintenance, prior service history queries, cash reconciliation and parts requisitions. This obviously requires much more interaction and access to the main system by field personnel.

These systems are more sophisticated than status-and-message systems. The data volume is greater, the screen in the vehicle may need to be bigger, data baud rates become important, server access limits need to be addressed, and more training is required. The role of the software and hardware vendor becomes that of a systems integrator.

Mobile computing

A mobile computing system is most commonly used by organizations with an in-house computer system when it is

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desirable to give field workers access to the system. Typical applications include IBM 5250 and 3270 emulation, but they can be extended to mini- and main-frame systems.

This type of mobile data system typically is limited to the host applications. The terminology refers to "transactions" or "sessions" instead of sending status reports or messages. Applications include public safety agencies and utility companies. Attention is given to transaction size, number of transactions, baud rates, host interface software and other aspects. The vendor's role in designing and implementing a system of this size and type and in connecting it with the customer's existing equipment is critical.

Although mobile data is not limited to the systems described above, these are the most common for fleet applications. Knowing this information, being familiar with hardware and software and having a fair understanding of how the component parts interact allows the interviewer to assess customer needs pragmatically. The interviewer must match customer needs to the best system, and that starts with the software. Sometimes the software is bundled as an integrated part of the hardware, and sometimes the software is stand-alone, making it possible to pick and choose the best hardware for the right software.

Armed with knowledge about the three primary types of mobile data systems, the next step is to define your role in helping your customer install a mobile data system. Most customers rely heavily on a vendor through the entire sales, installation and integration process. You need to know your strengths and weaknesses at the beginning.

Historically, a radio communications shop is used to dealing with hardware, but deals with software usually only to the extent of programming. Installing a sophisticated mobile data system could require extensive engineering, after-sales software support and lots of computer expertise. Most radio shops are not willing to be a systems integrator—and probably should not take the risk. Most shops are comfortable with off-the-shelf products that require a minimum of customation. Radio communications is a hardware solution; mobile data is a software solution.

On the other hand, status-and-message data equipment can and should be sold, installed and supported by two-way radio shops. Most terminal manufacturers provide the hardware connection and interface information necessary for many of the radios on the market, especially from large manufacturers. Most terminal manufacturers also provide a basic software communications package that allows the dispatcher to send messages to the drivers and to receive status updates from the trucks.

Most terminal manufacturers also provide for custom design of the keyboard, button mapping, screen formatting, status indicators, algorithm and sequence. With the custom features from the manufacturer and the basic communications software, status-and-message mobile data units can be sold off the shelf as easily as any radio. More sophisticated computer-aided dispatch (CAD) software is being developed for status-and-message terminals by several vendors.

Status-and-message mobile data is a good way for specialized mobile radio (SMR) system owners and operators to increase revenues without compromising spectrum. Because most radio shops fear the unknown, other shops that embrace mobile data will find less competition and higher profit margins.

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Finding the needle in an electronic haystack

Recording and playing back voice communications from a trunked radio system requires less equipment with a method that records 'raw' RF channels. Digital compression techniques extend recording times to more than 24 hours.

By Carl J. Swift

So you want to record audio from a trunked radio system? Nothing to it. With a multitrack recorder and audio sources from trunked receivers or directly from the trunked radio system, you are in business.

Sometimes, though, we do not say exactly what we mean.

Before surgery begins, we say we want the anesthesiologist to put us to sleep—when what we really want is for the good doctor to *wake us up* afterward. We say we want a drill bit—when what we want is a *hole*. When we talk about recording a trunked radio system, what we really want is to be able to *hear* what was said in a *particular conversation*. When it comes time to listen to a particular conversation—especially if it had been a "private" conversation, there may be a serious problem. After a trunked radio system has changed channels a few times, finding and playing back a particular conversation is more difficult than finding a needle in a haystack.

Recording (logging) a conventional two-way radio system is easy. An ordinary, multichannel (multitrack) recorder works fine. Finding and replaying a conversation requires only that you position the tape and play the correct channel.

Logging a trunked radio system is another matter. Figure 1 below shows communications activity on a typical, small, trunked system. Routine talk group transmissions, private transmissions and a telephone interconnect call are color-coded. Notice how the individual transmissions hop from one frequency to another. Transmissions move around for several reasons.

The frequency-hopping allows the system to find an open channel. Furthermore, it ensures a more even channel-loading.

Many trunking radio systems are equipped for telephone interconnects and "private" conversations. Logging a telephone interconnect conversation is not normally a problem because the recorder can be connected to the telephone lines that are dedicated to the system controller.

Private calls, on the other hand, present a number of problems. Contrary to popular belief, a private call does not tie up a physical radio channel as a telephone interconnect does. Instead, a private conversation is, to the trunking radio system, an ad hoc "talk group" that is created on the spot for the two radios involved in the private call. There is no formal redefinition of the programmed system talk groups, and, when the private call ends, the ad hoc "talk group" vanishes.

Previously, the only way to log and record a trunking radio system was to de-trunk the talk groups prior to recording and to use a standard multichannel (multitrack) recorder. With this method, you need equipment to de-trunk each talk group, and private conversations are extremely difficult to record—if you can record them at all.

There are several solutions.

1. Do not assign many talk groups. (Unfortunately, this would defeat the effectiveness of the trunking radio system.)

2. Do not allow private calls. (Unfortunately, this would limit management and supervisory effectiveness.)

3. Do not create new talk groups until you have the necessary equipment and recording channels to capture them.

These probably are not practical solutions.

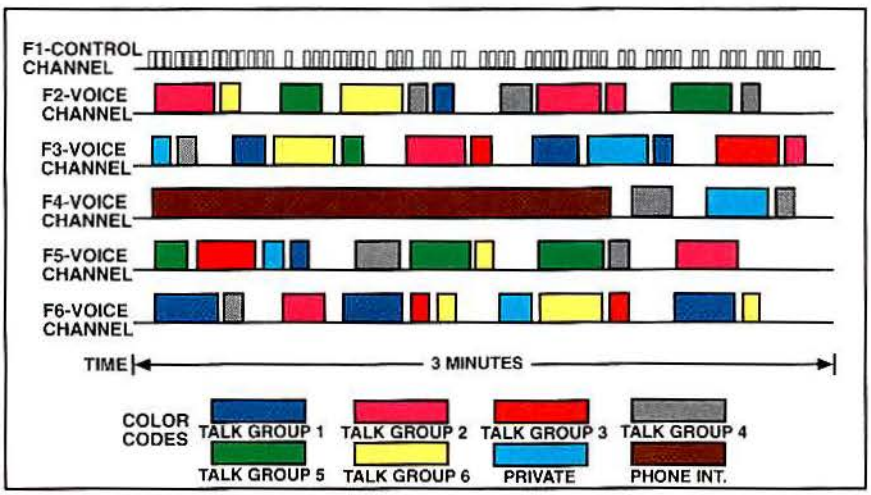
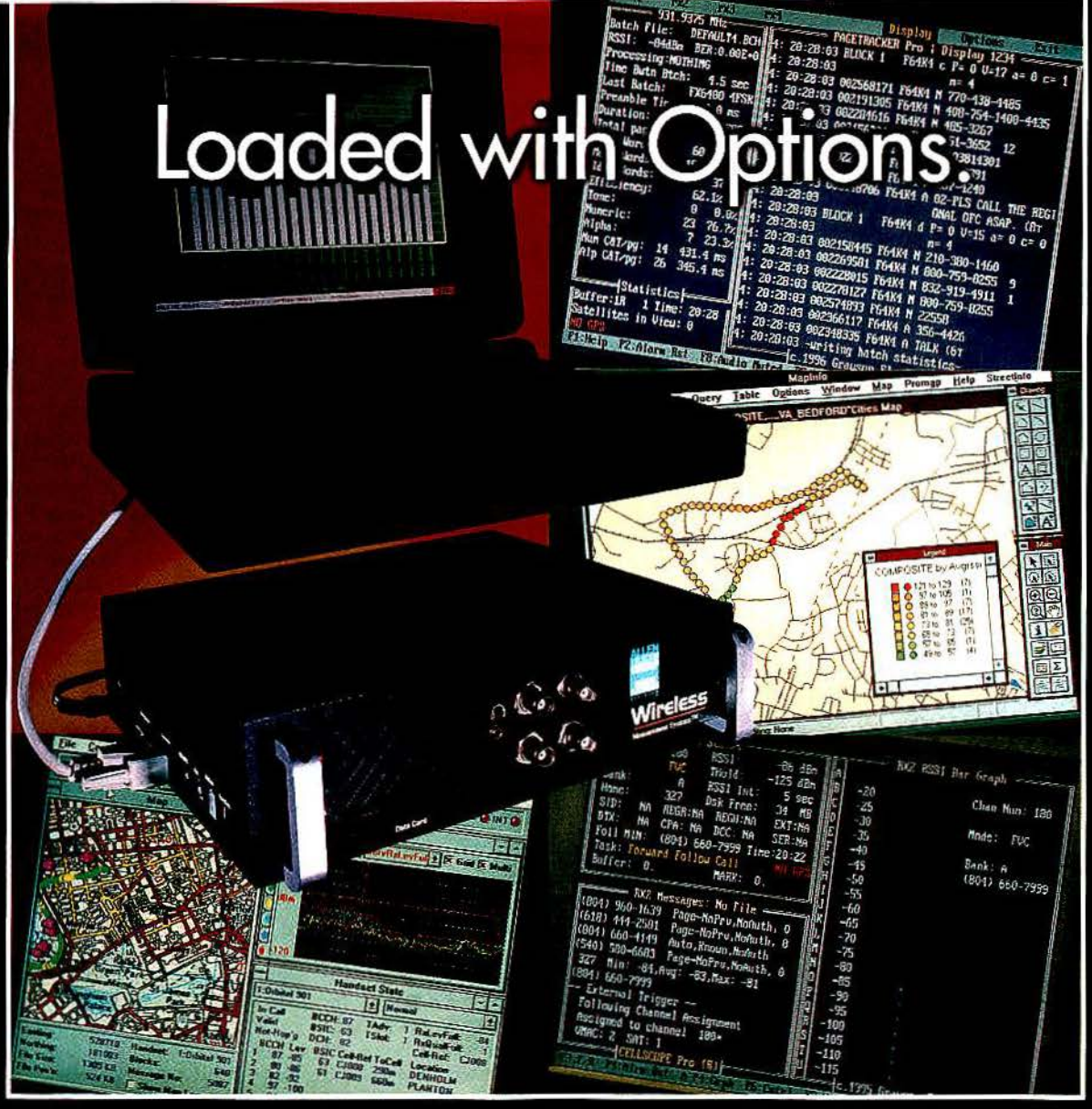


Figure 1. Communications activity on a typical, small, trunked system. Routine talk group transmissions, private transmissions and a telephone interconnect call are color-coded. Notice how the individual transmissions hop from one frequency to another.

Real world example

In July 1985, Houston Lighting and Power was planning its new trunking radio system. Because the utility experiences some damaging weather conditions, its trunking radio system was designed for

Swift is president of Swift Computers, Stafford, TX. The logging recorder for trunking radio systems described in the article is the company's Swiftstor/Smartstor system.



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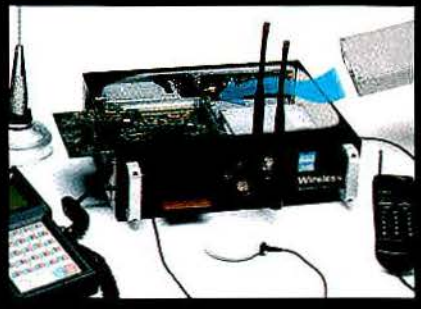

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Figure 2. One of the recorder's two primary CRT screens provides system status information including *RF channel activity* and *tape status*. A mouse can be used with this screen to select "live" radio system monitoring by talk group, radio ID or RF channel.

the worst. Part of the plan was to give the electric system managers plenty of radio resources, give them control and trust them to use the resources wisely. The trunking system was designed in 1985 with more than 2,000 radios in six fleets, 90 departmental talk groups and six all-call talk groups. Since then, it has been expanded to include 130 talk groups. The trunking system has telephone interconnect, and certain radios are programmed to allow private calls.

Recording the power company system using the "de-trunking" method would have required 90 (now 130) base receivers capable of trunking (one for each talk group), three 40-channel logging recorders and all of the wiring, power supplies and ancillary equipment needed to connect this equipment together. When the cost of 90 receivers and three logging recorders (each generating a reel of tape per day), as well as the inability to record private conversations, was considered, the detrunking recording method was shown to require overwhelming manpower and funds, yet it would only provide a partial solution at best. A further drawback of the "de-trunking" system is its requirement of additional hardware—a receiver and logging recorder channel—each time a new talk group is added to the system. After a certain point is reached, depending on system design, a major expansion of the fixed-end equipment may also be required.

Alternative solution

Remember, the desired result is the ability to selectively recover *any* radio transmission based on talk group, individual radio ID or RF channel. It is impossible to predict which transmissions will be of interest, so another solution is to record the RF channels "raw" and, using trunking control channel information, build an index of all transmissions. When it comes time to play back a particular transmission, a computer can search the index and play the desired transmissions.

One method for such recording uses an analog, multitrack recorder, and another uses a digital recorder. Although both methods are feasible, the digital version is preferred for several reasons.

1. Digital technology is moving ahead rapidly.

2. Digital hardware costs are decreasing.

3. A digital recording system is, in reality, a computer, and computer experience is useful in solving difficult problems.

The idea of recording the RF channels "raw" and de-trunking only when necessary significantly reduced the recording system's hardware requirements. Instead of needing an audio source and digitizer for each talk group, only an audio source and digitizer are required for each RF

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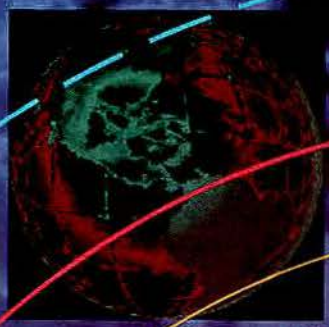

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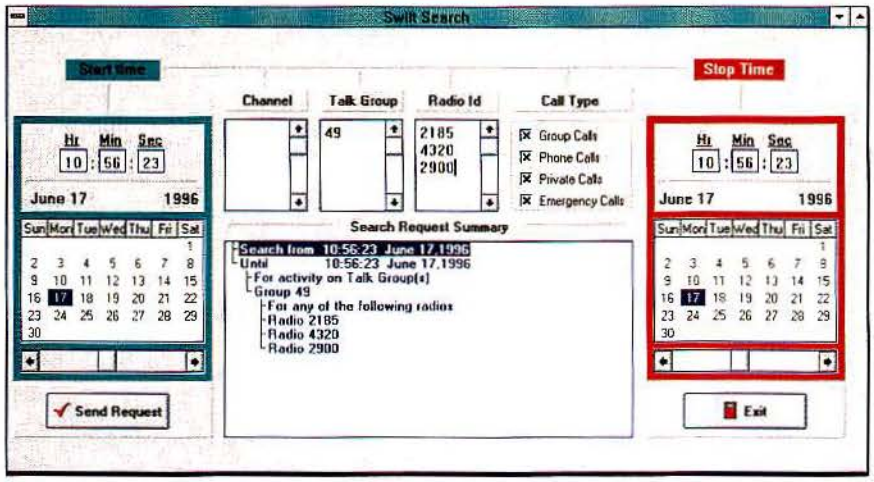

Figure 3. The *search screen* is used to recover and play back selected conversations by talk group, individual ID or RF channel. Several options are available to control the date and time limits for the search. A smaller search range results in faster searches.

channel, i.e., a 25-channel trunking system needs only enough hardware to receive audio information from the 25 RF channels, plus one receiver for the the control channel information, *regardless of the number of talk groups or subscriber units on the system.* The only time that more hardware is required is when another RF channel is added. Adding one receiver per channel, one digitizer or digital signal processing (DSP) channel and a minor software modification activates the logging recorder system for the new configuration.

Choosing the medium for archive storage also presented a challenge. The selected medium would need enough capacity to record a "failsoft" condition of every RF channel transmitting continuously for at least 24 hours. Two commonly available computer cassette tape drives and an optical disk were selected as possible candidates.

The tape drives offer large capacity; prices for the drives themselves and the cassettes are reasonable; and they provide reasonable recovery times. One cassette system uses commonly available 8mm video cassettes and has 5 Gigabytes (GB) of capacity on a cassette. Digital audio tapes (DAT) offer 4GB of capacity at a higher cost per 4mm cartridge. Both drive systems have acceptable performance and capacity.

The compact disc, read-only memory (CD-ROM) optical drives do not have sufficient capacity yet; nevertheless, by using the small computer system interface (SCSI) buss for tape drives, disk drives or both, future storage devices and improvements can be readily accommodated.

Both the 8mm video tape drive and the DAT 4mm tape drive use helical scanning, and frequent starting and stopping is *not* recommended. To overcome this

Continued on page 44

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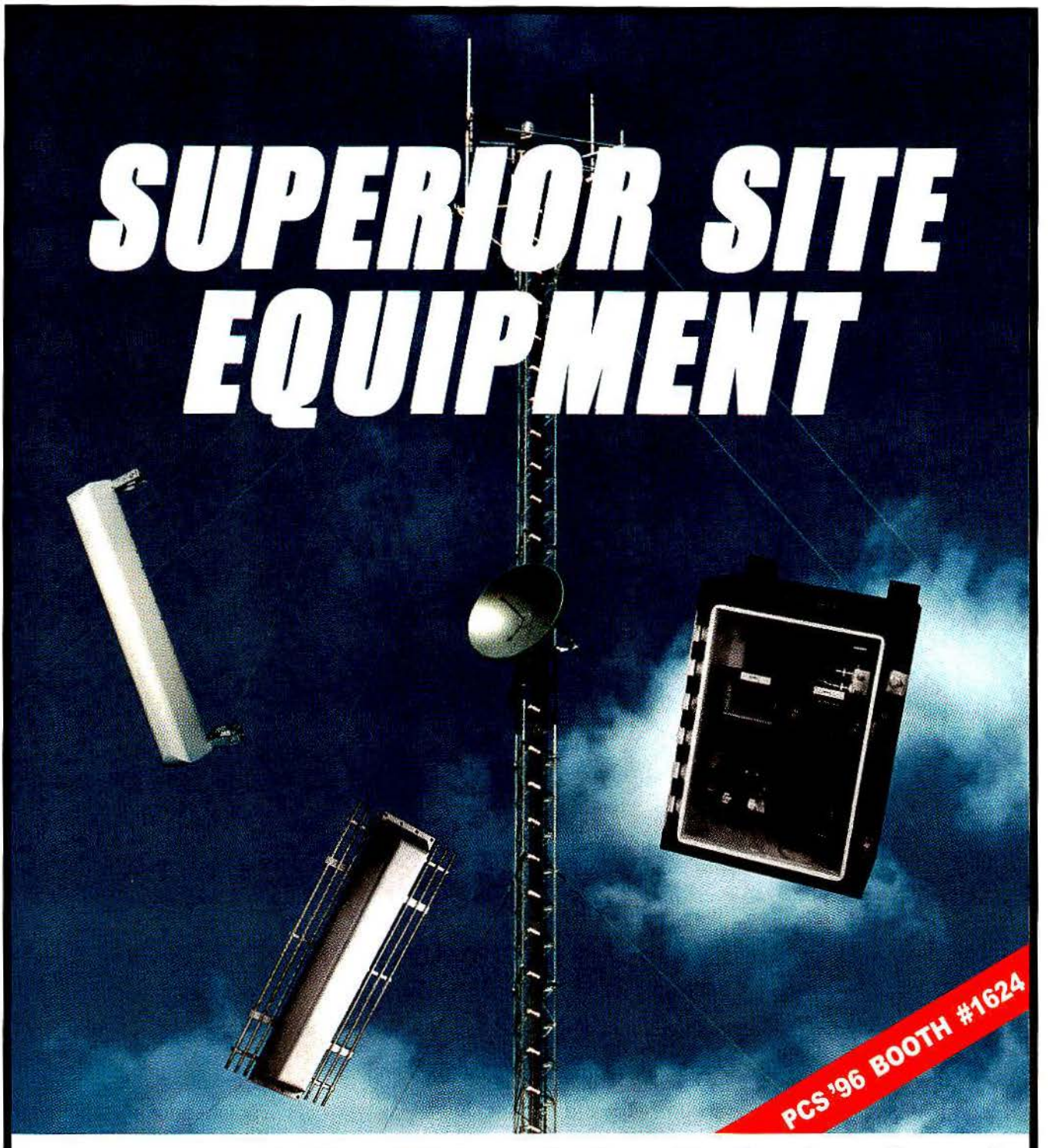

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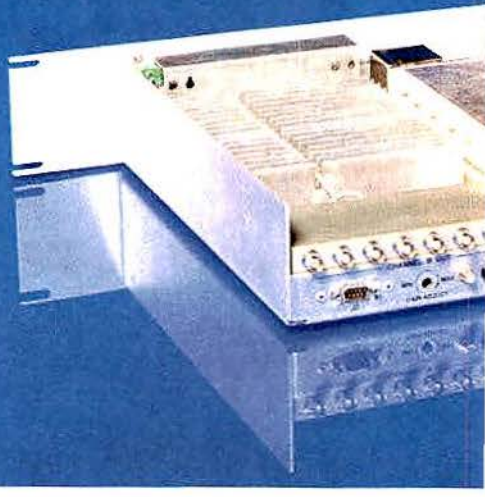

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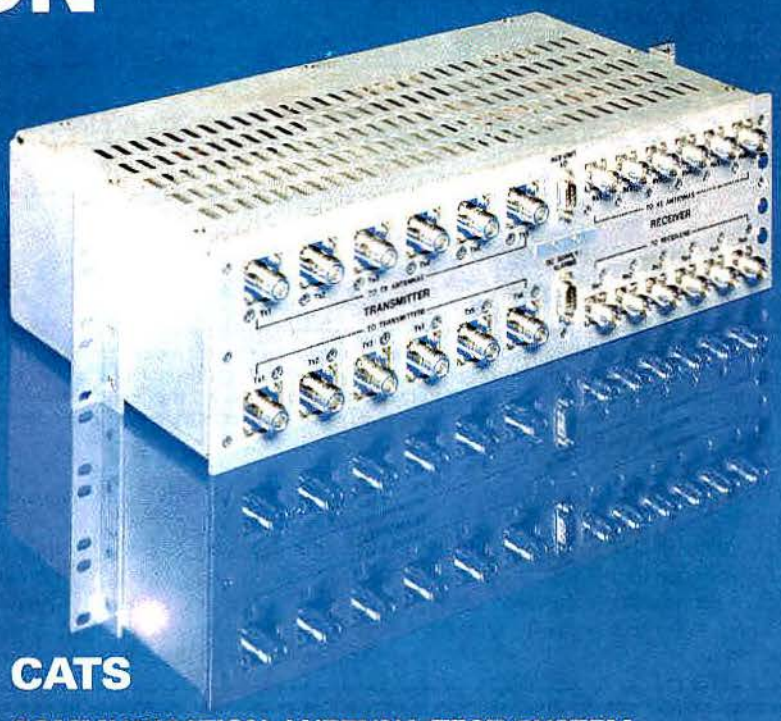

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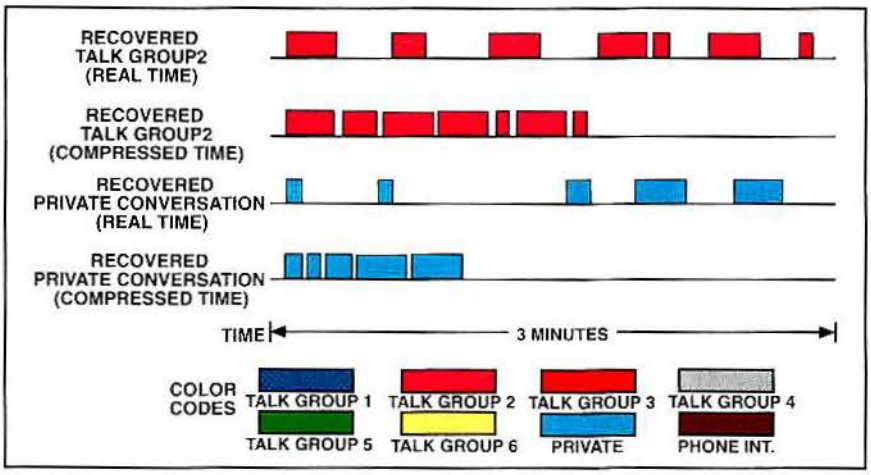

Figure 4. The system's two playback modes include the *real-time mode*, which plays individual transmissions in sequence with the original interval between transmissions, and the *compressed-time mode*, which plays individual transmissions in sequence with an interval of 1–2 seconds between transmissions—a great convenience when a series of transmissions occurred over a 10-to-15-minute period.

continued from page 40

limitation, a hard disk drive was incorporated as a large buffer to:

□ buffer the incoming digitized audio until enough is stored to justify starting the tape drive.

□ make possible simultaneous recording and playback.

It is not necessary to use a separate device for playback. The simultaneous record-and-playback capability permits unattended operation and remote playback.

The breakthrough that makes it possible to record the radio system for more than 24 hours on a 4GB or 5GB tape is the use of voice compression algorithms and DSPs.

Even so, the problem is more complex than finding a needle in a haystack. You have to find a series of needles in a *needlestack*. You must label and file the needles in an organized way when you store them and create a directory and an index for finding the specific needles you want.

How it works

The logging recorder has a digitizer and compressor operating continuously for each RF channel, outputing one-second packets of digitized audio. During periods with no activity on the trunked system—intervals with no active channel grants—these packets are discarded. When the trunking control channel issues a channel grant, the recorder generates a header that contains the date, time, RF channel, talk group and unit ID. The logging recorder's main processor commands the DSP to save the packet and to append the header. The main processor then writes the completed packet to the hard disk and writes an index record in two locations. When a "save set" of about 50,000 channel-second voice packets

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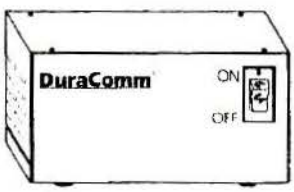

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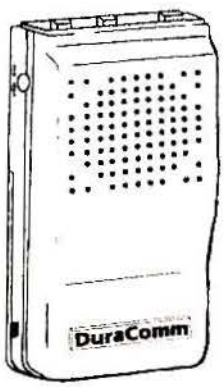

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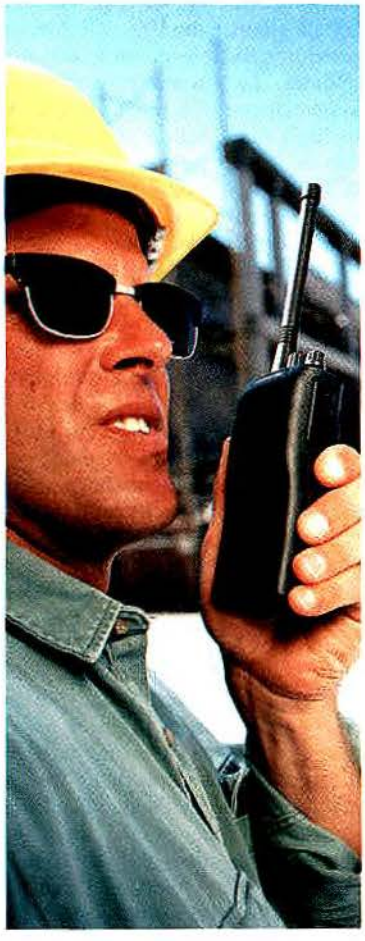

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(about 50MB) is stored on the hard disk, the file is closed, and a new "save set" is opened. The processor then transfers the closed "save set" to tape for permanent storage. Depending on capacity, a number of "save sets" are retained on the hard disk until space is needed. When space is needed for record or playback, the oldest "save set" is erased, and a new "save set" takes its place.

The multitasking computer can record, play back and transfer voice packets among the DSPs, disk drives and tape drives and still have time to drive a simple video display. Even so, the advantages of this technology would be limited if the system were difficult to use. To speed the training and to minimize the complexity, *two* computers are used. One runs the *recorder*, and another serves the *people* using the system. The "people server" is a Windows-based PC that provides local control, a local area network (LAN) interface or modem access to the recording system.

The people server's Windows program has an attractive, easy-to-use search capability that can recover radio conversations by talk group, radio ID or RF channel while providing system control and operating updates. To minimize search time, the system requests a time-and-date window to limit the extent of the search. If the conversation sought remains on the hard disk and if the time window is not too large, search results and playback usually are available in less than 30 seconds.

The people server provides three important displays. The primary screen, shown in Figure 2 on page 38, provides system status information including *RF channel activity* and *tape status*. A mouse can be used with this screen to select "live" radio system monitoring by talk group, radio ID or RF channel.

Figure 3 on page 40 shows the *search screen* used to specify searches by talk group, individual ID or RF channel. Several options are available to control the date and time limits for the search. A smaller range results in faster searches.

Playback audio can be delivered as local analog audio, remote analog audio (via phone) or as a digital sound file with the .WAV extension for playback on a multimedia-equipped PC. Figure 4 on page 44 illustrates the two playback modes. The real-time mode plays individual transmissions in sequence with the original interval between transmissions. The compressed-time mode plays individual transmissions in sequence with an interval of 1–2 seconds between transmissions—a great convenience when a series of transmissions occurred over a 10-to-15-minute period.

Playback security can be provided by both password and hardware if desired. Physical and performance security can be provided by redundancy.

One frequently asked question is "What happens if the desired 'save set' has been transferred to the tape and erased from the hard disk?" The system checks its directory for the tape volume where the "save set" is stored. If the tape is still on the machine, the oldest "save set" on the hard disk is erased, the desired "save set" is copied from the tape back to the hard disk, and the desired conversation is played. If the tape has been removed, a request will be displayed to load the needed tape volume. Another optional capability is to use a "carousel" or "juke box" system available in several sizes with as many as 100 tapes. With the carousel or juke box, the system automatically loads the needed tape, if it is available.

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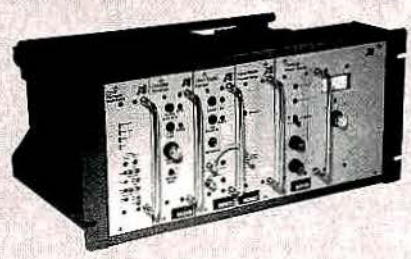

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Tracing foreign interference in the cellular band

Almost every interference problem can be solved, but first you must identify its source. Observations made with test equipment and radio direction-finding are among techniques used by investigators.

By Joseph Darlington, P.E.

Cellular telephone service providers deal with radio frequency interference problems on a daily basis. A sudden increase in noise, crosstalk or dropped calls in one cell normally causes cellular engineers to assume that there is a problem with co-channel or adjacent-channel interference from another cellular base station or a mobile subscriber unit in the network. Do not forget, though, that the radio spectrum also is occupied by broadcast, paging, specialized mobile radio (SMR) and other transmitters, any of which can introduce harmful interference into the cellular band.

Foreign interference (that which is caused by non-cellular radio transmitters) can occur anywhere, but it happens more frequently where cell sites are co-located with other transmitters. It has been one of the trickiest problems to solve, simply because methods of identifying the interferers are not well-established among cellular system providers. Actually, the task is easier than you might think. You can track down just about any source of foreign interference, not just in the cellular band, but for other radio services as well, as long as you have patience, persistence and a spectrum analyzer.

Gather information

Gathering information is the first and most important step in solving an interference problem. Find out the symptoms: for example, noise in the audio path or dropped calls that cannot be traced to hardware failures or cellular frequency reuse. Determine whether the problem occurs within a large geographical area or whether it is limited to a particular cell site's coverage area. Determine whether the affected cell sites are co-located with other transmitters. Also, find out which channels are affected by the problem and which operating band is affected—the mobile transmit band or the base station transmit band.

With the necessary background information in hand, visit an affected site for a first-hand look with a spectrum analyzer. Where in the spectrum should you start to look? Unless you have prior information that indicates otherwise, start in the mobile band. Interference is much more likely to be a problem in the mobile band where the interferer easily competes with and overpowers the relatively weak signals (typically 0.6W) from cellular subscriber units.

Sample what the cell-site transceivers are seeing by connecting the spectrum analyzer to the cell-site receive multicoupler. Set the spectrum analyzer to display the entire mobile band and adjust the resolution bandwidth to about 3kHz. First, observe the noise floor. Does it rise and fall as you watch? Is it reasonably flat, or is it higher at either band edge? Noise floor irregularities may indicate faulty cell-site hardware or an interferer close to the receive antenna.

As the next step, perform an over-the-air test, both inside the cell site and at a reasonable distance from the cell-site antennas. Connect a passive, portable antenna to the spectrum analyzer and view the affected band. Compare this unfiltered and unamplified view with the one seen through the cell-site receive multicoupler. An over-the-air test often reveals a distinct interfering signal, whereas the view from the receive multicoupler may show intermodulation or broadband noise.

For example, when our company received customer complaints of loud

Photo 1. Patience is required when comparing an interferer with legitimate signals elsewhere in the spectrum.

Darlington works in the System Planning and Performance Group at AirTouch Cellular, Irvine, CA.

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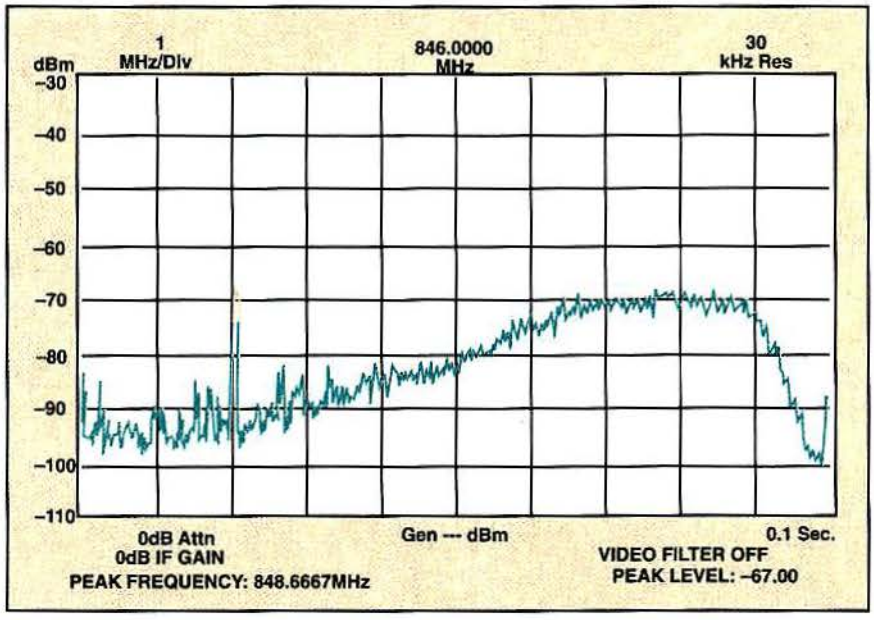

Figure 1. Out-of-band emissions from an SMR transmitter operating in the 851MHz–869MHz band created this high-amplitude noise in the cellular mobile transmit band. (A full view of this problem is prevented by the cell-site preselection filter.)

background noise in calls made near a particular cell site, our first step was to view the affected band through the cell-site receive multicoupler. No distinct interfering signals were observed, but the noise floor could be seen spontaneously rising above −75dBm, then falling to a normal level. Later, an over-the-air test performed about 100 feet from the antenna tower made the problem evident. An odd-looking spurious emission was being produced by a co-located SMR base station transmitter, and was being radiated from its antenna on a shared tower. (See Figure 1 at the left.) This spur, being radiated close to our receive antennas, had been overdriving the cell-site preamplifiers and causing strong receiver intermodulation. The problem might have never been identified without the over-the-air test.

Some engineers do not like to perform the over-the-air test, citing the need for greater antenna height and for increased receive sensitivity provided by the cell-site preamplifier. My advice is to first test for strong interferers before looking for the weak ones. If you suspect the interferer is lurking in the "grass" near the bottom of the spectral display, decrease the resolution bandwidth on the spectrum analyzer. This will lower the displayed average noise level and expose any weak signals. To provide a height advantage for your antenna, use an elevated-feed antenna mounted on an extendible pole. Any

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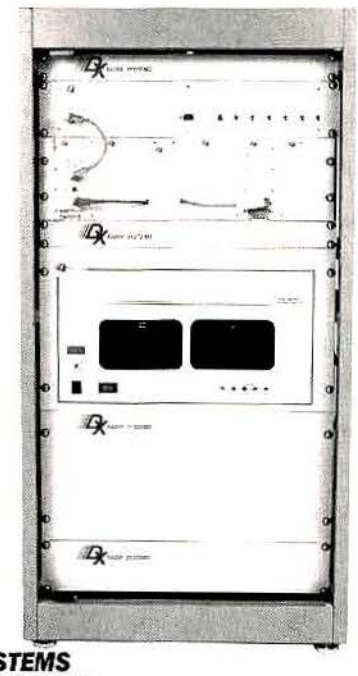

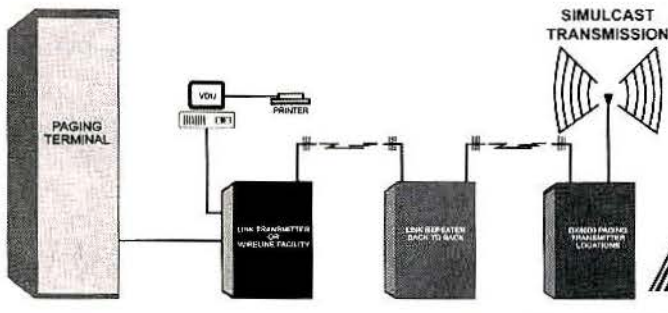

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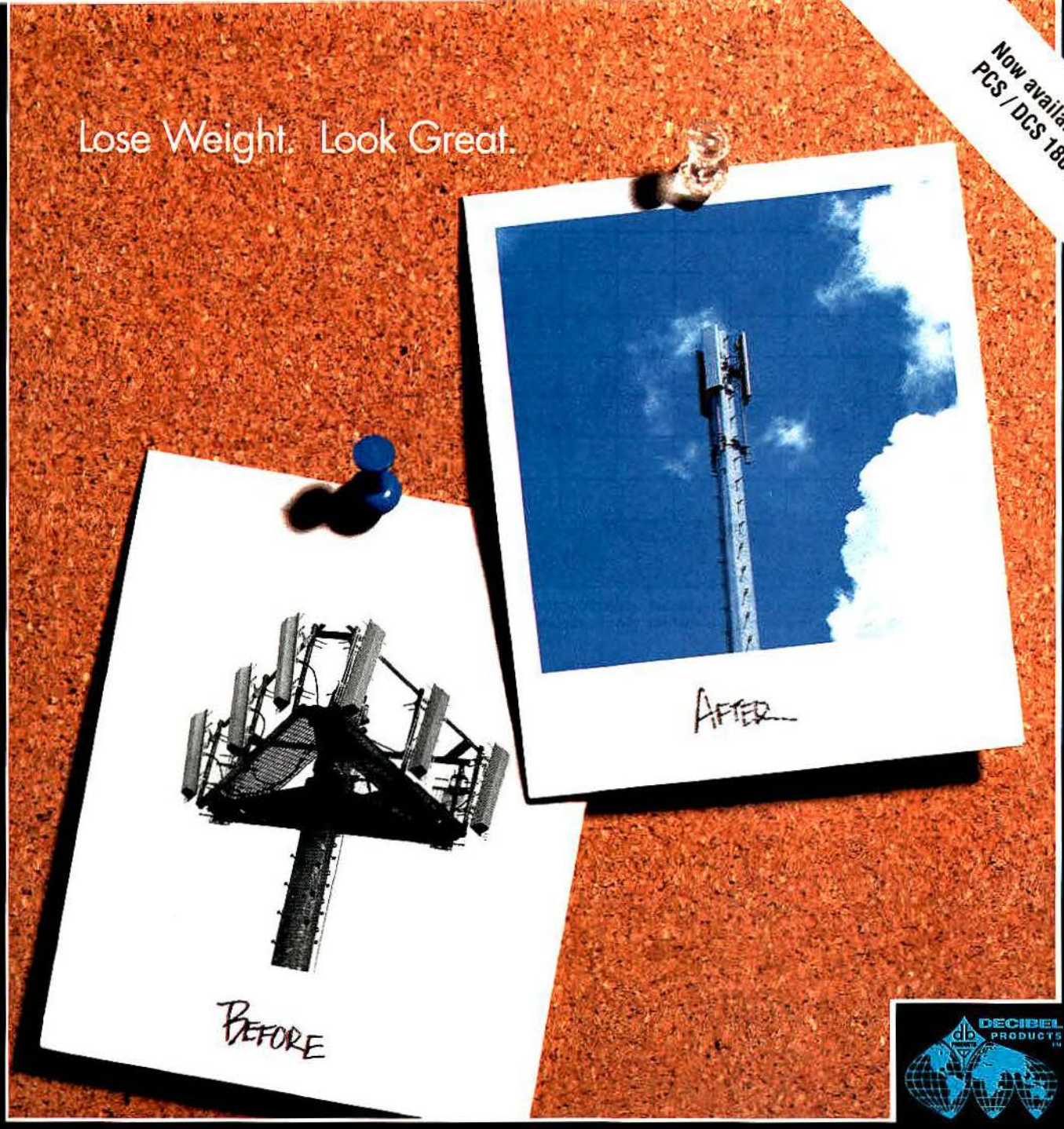

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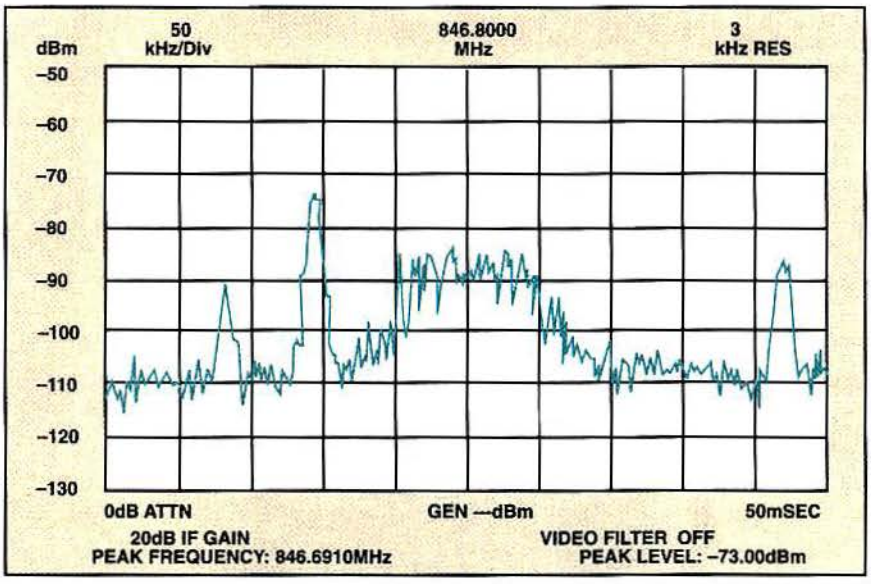


Figure 2. A spurious emission from an FM broadcast transmitter (center of screen) is distinguished by its wide bandwidth. Legitimate signals from cellular mobile subscribers are seen on either side.

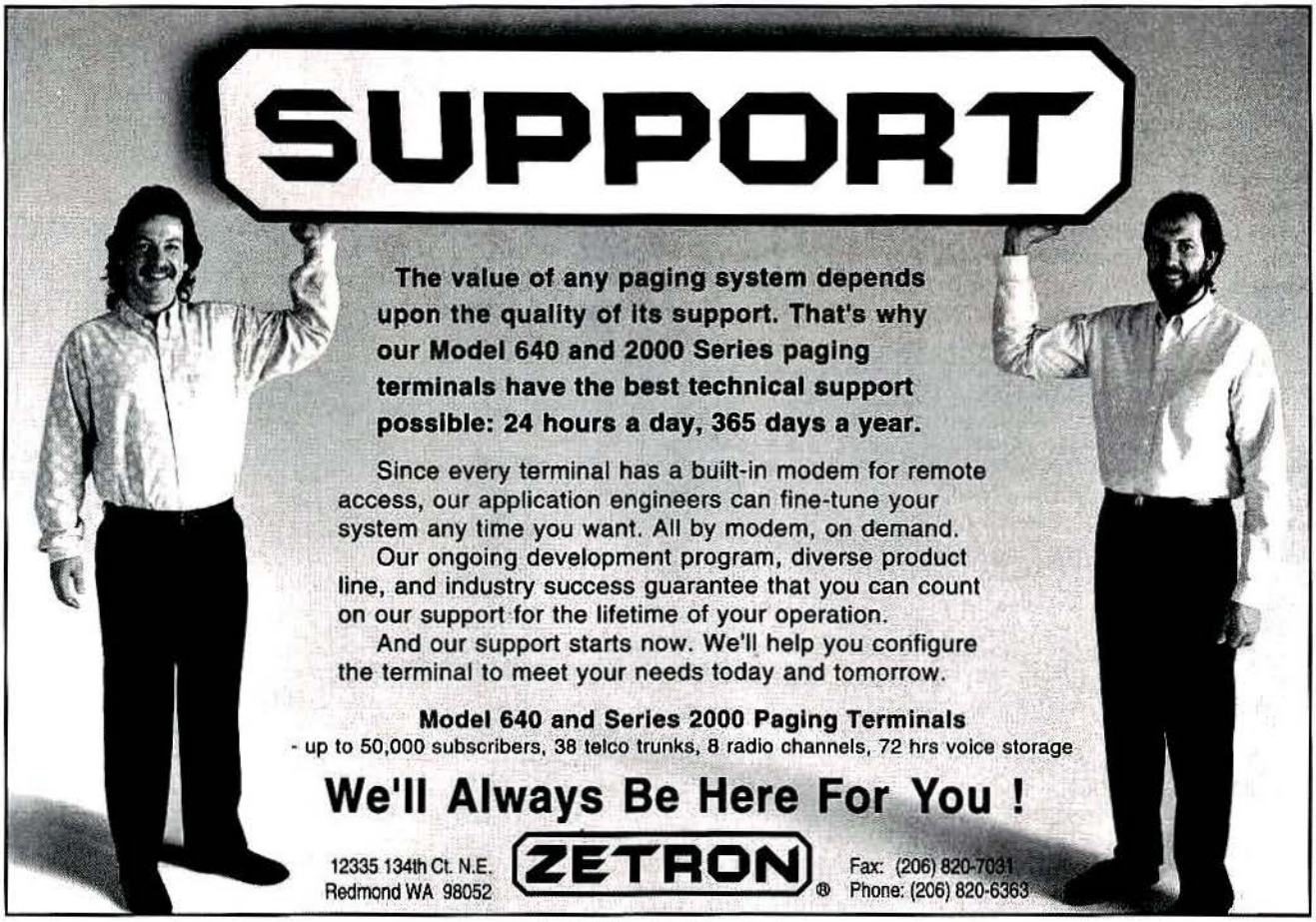
way you work it, perform the over-the-air test. It is critical.

Look and listen

Once you have observed a potential interfering signal, take a good, close look. Every type of radio emission has unique characteristics and, after some observation, you often can tell whether a signal is legitimate or whether it does not belong in the band. (See Photo 1 on page 48.) For example, Advanced Mobile Phone System (AMPS) cellular signals, as seen on a spectral display, vary in amplitude, but always fit within their 30kHz assigned bandwidth. Also, the AMPS signal's transmission pattern is such that it normally occupies the same channel for a period of 30 seconds to several minutes. By comparison, a signal that pops up and down quickly on the same center frequency more likely originates from a push-to-talk type transmitter or a paging transmitter. A signal that stays up constantly or that occupies a wide band probably originates from a broadcast station. (See Figure 2 at the left.)

If you suspect that a signal is a foreign interferer, attempt to demodulate the signal as AM, FM and single-sideband (SSB) ... and then listen. A surprisingly large percentage of interferers carry clean, uncluttered baseband information that is useful in identifying the type of station. Note whether the baseband signal is intelligible as voice or as digital signaling. Also, listen for the broadcast of station call letters, which may be transmitted in either voice or Morse code.

One of the trickier problems was an



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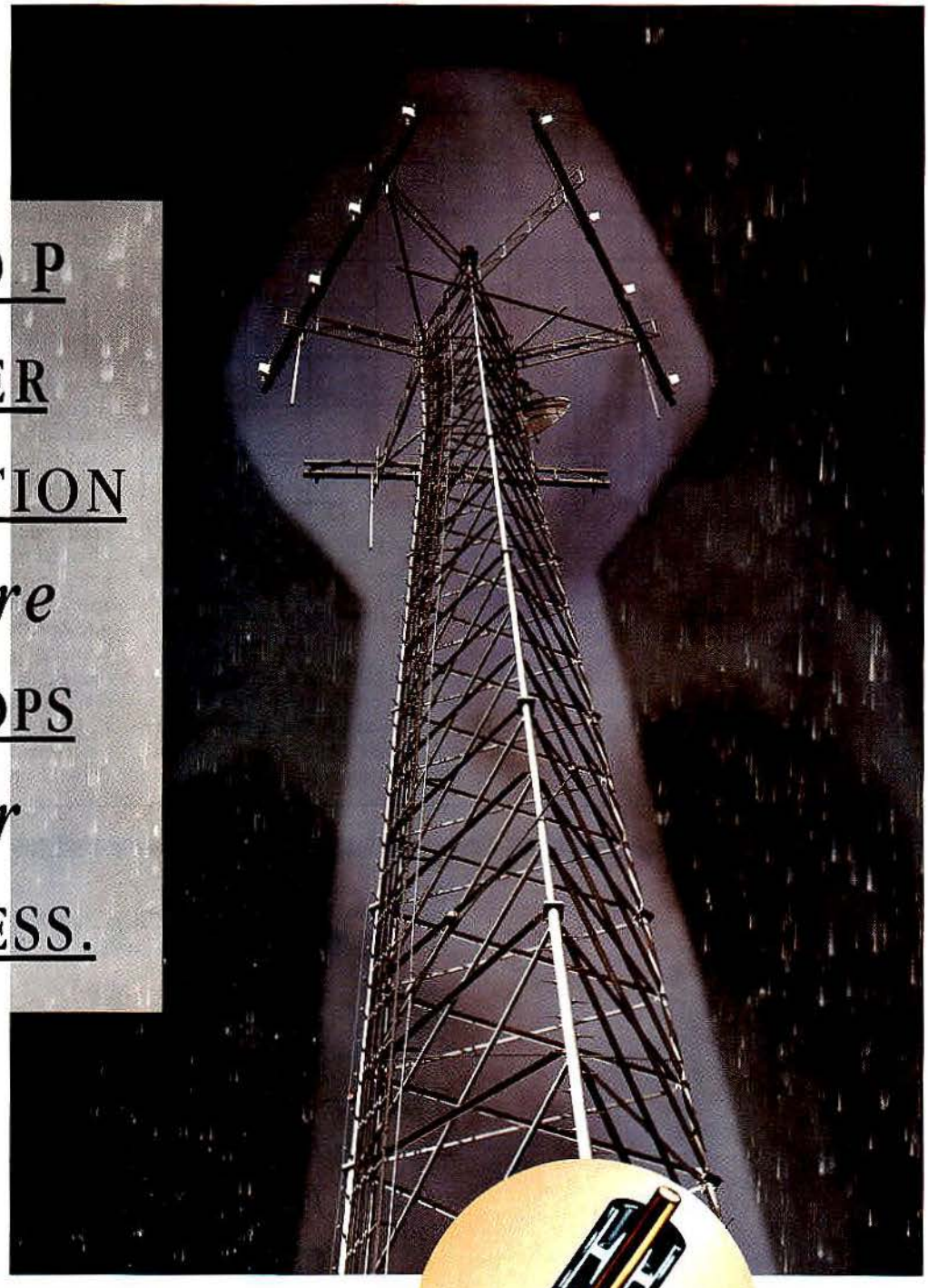

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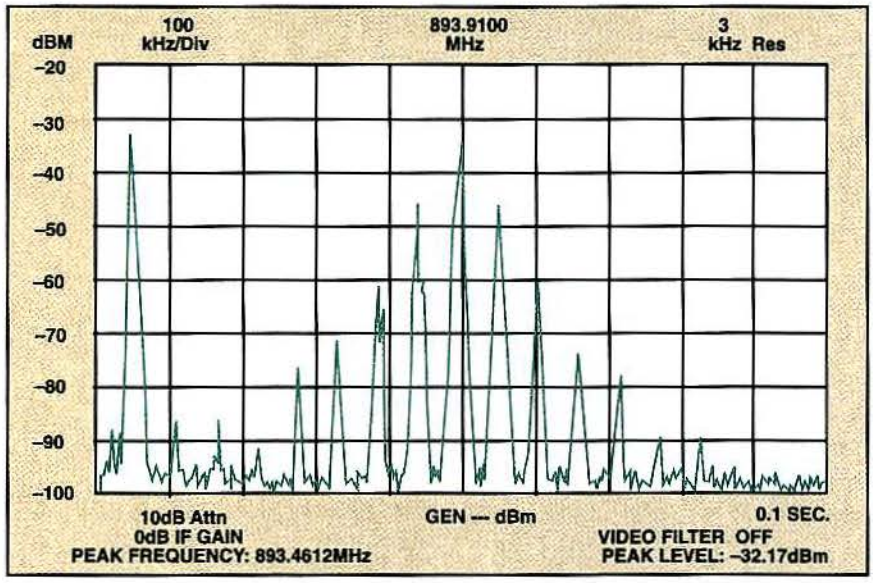
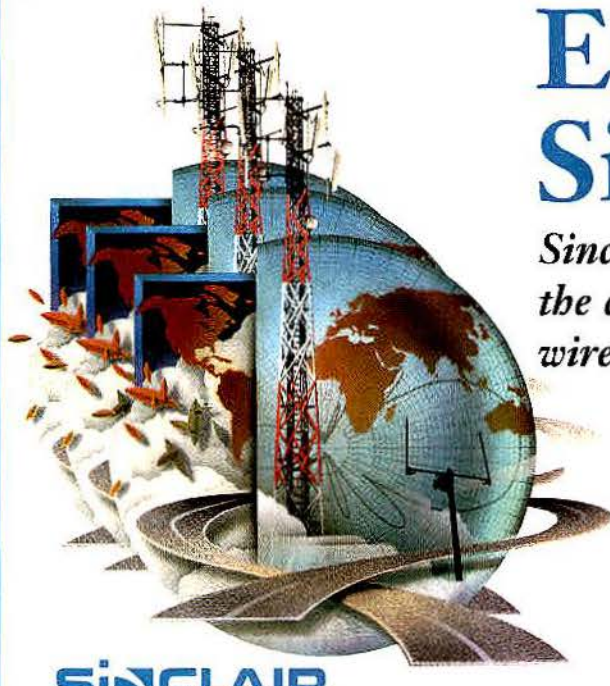


Figure 3. Not all 'foreign' interferers are foreign. A transceiver in our own cell site generated spurious sidebands along with its legitimate signal, seen in the center of the screen. A signal from a normal transceiver appears at the far left.

interferer that, on the spectral display, looked much like an AMPS signal. Although it was not centered on an AMPS channel, the signal was frequency-modulated with voice traffic that sounded like a cellular call. The transmission pattern also was consistent with a cellular call. The problem became apparent when two other signals on the spectral display were observed to pop up and down in unison with the targeted interferer. Tuning quickly among the three signals and demodulating them revealed that they all carried the same voice traffic. The interferer was found to be one of several strong spurious emissions generated along with a legitimate signal from our own cell site. (See Figure 3 at the left.) Although this interferer was not exactly "foreign," it definitely was out of the ordinary, and it never would have been identified using conventional methods of cellular testing.

Direction-finding

Sometimes observing interferers from a distance is not enough, and you may need to use one of the oldest troubleshooting methods, radio direction-finding. The art of radio direction-finding has been practiced for years by radio amateurs who often participate in organized transmitter-hunting contests, or "T-hunts." Modern, specialized direction-finding gear uses microprocessor control and electrically scanned antenna arrays. In most cases, though, using a hand-held directional antenna, such as a yagi, in conjunction with a signal strength meter or spectrum analyzer can bring successful results. (See Photo 2 on page 56.)



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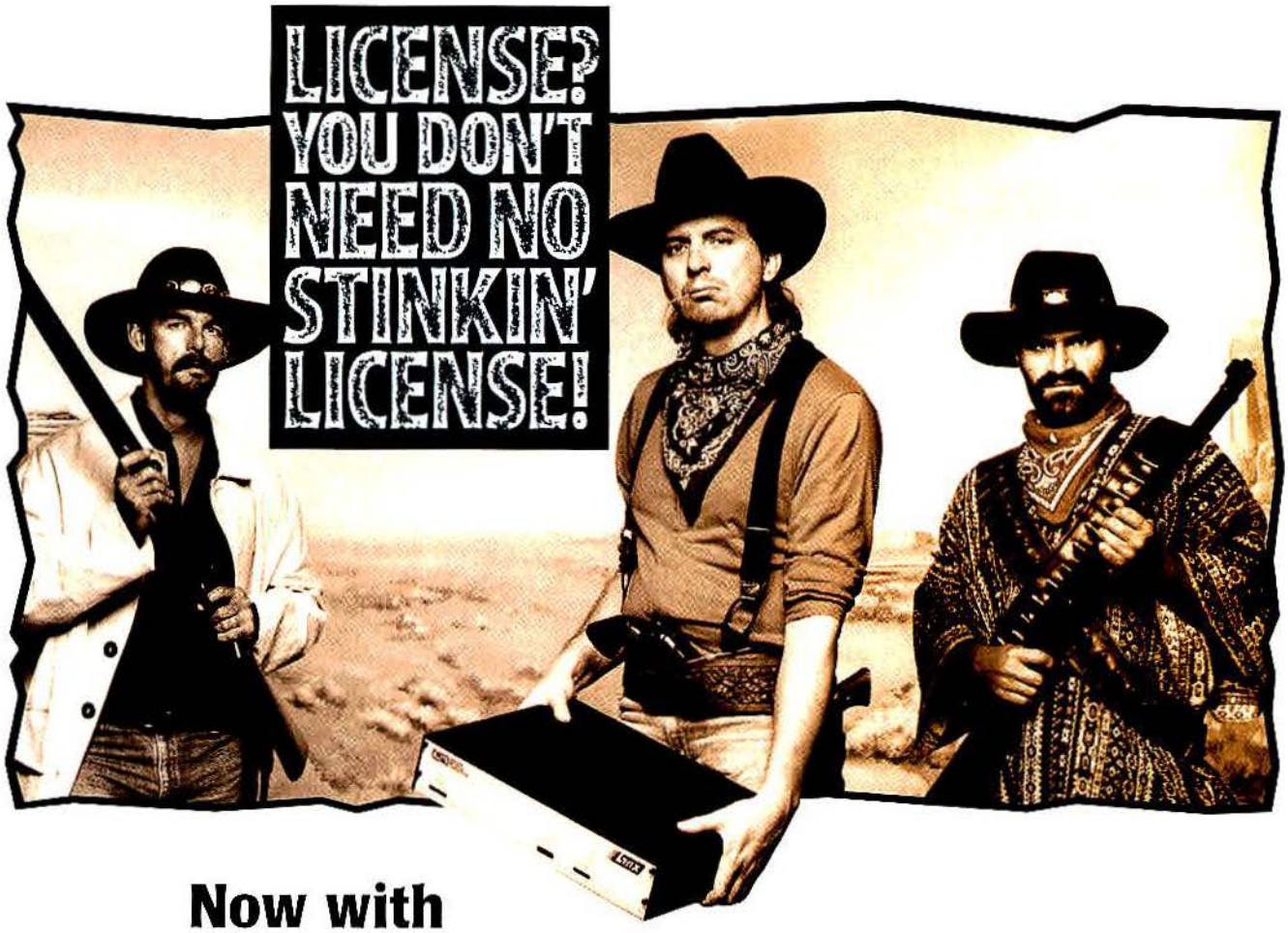

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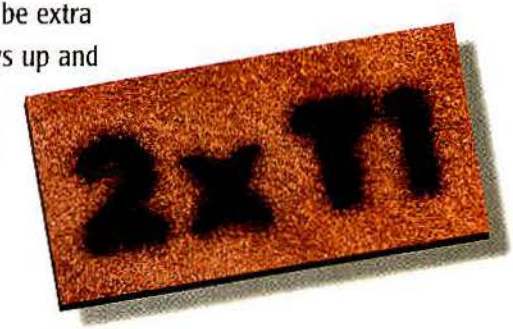

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To start, connect a directional antenna to the input port of your measuring device. For a spectrum analyzer with a digitizing display, speed up the sweep by widening the resolution bandwidth and narrowing the scan bandwidth just enough to see the full width of the signal. Signal strength meters or receivers equipped with a signal strength meter are even easier to use. When using a signal strength meter, be sure to narrow the filter bandwidth enough to reject any strong adjacent signals.

With the directional antenna mounted on a pole or even a broom handle, sweep the antenna through 360°, watching the spectral display or signal meter as you do so. Observe how the signal strength of the interferer rises and falls as the pole is rotated. Reflections or re-radiations on other antennas in the area may cause false readings, but as a rule, the strongest signal reading will consistently be seen on a single line of bearing.

Once a fix is found in azimuth, face the predominant direction of the interference source, move to your right or left, and repeat the process. Move closer to your target until you have a potential source of interference in view. Continue to move around your target and confirm your fixes in azimuth. Next, confirm your fix by sweeping the antenna up and down in elevation. This step is critical when the interferer is located high on a tower.

Photo 2. Direction-finding is a tried and true method of locating an interferer.

Keep in mind always that your target signal could be anywhere—even inside your cell site or inside your spectrum analyzer. Radio direction-finding is as useful in finding out that you have an equipment problem as it is in finding foreign interferers. If your efforts to direction-find do not yield a distinct line of bearing in azimuth and elevation, check your test equipment and cell site equipment.

Search and compare

The methods described above are effective in tracking down an interferer, but the most definitive method is to witness a simultaneous transmission from a legitimate transmitter licensed to operate elsewhere in the radio spectrum. The best way to do this is to monitor the affected cellular band while using a second spectrum analyzer to search the rest of the spectrum, one frequency block at a time. Searching for a legitimate signal somewhere in the spectrum can be like looking for a needle in a haystack, but the task can be simplified if you follow a few helpful hints.

First, use the information gained in the previous steps. If the transmission pattern or the demodulated baseband information consisted of "bursty" digital signaling,

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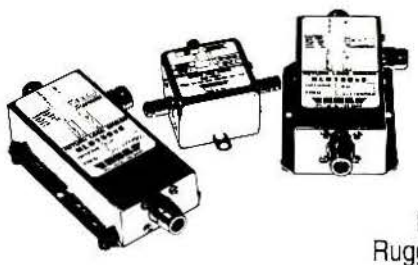

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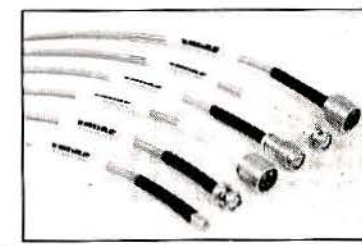

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	TV Broadcast	base sta. TX
806.0 MHz	Public Safety, Industrial, SMR, Land Transportation	mobile TX
824.0 MHz	CELLULAR	mobile TX
894.0 MHz	Air-Ground Phone	mobile TX
851.0 MHz	Public Safety, Industrial, SMR, Land Transportation	base sta. TX
869.0 MHz	CELLULAR	base sta. TX
894.0 MHz	Air-Ground Phone	base sta. TX
896.0 MHz	SMR, PCS, Mobile Data, Vehicle Location, Amateur Radio	mobile TX, some base station TX
928.0 MHz	Land Mobile, Fixed Microwave, Paging	base sta. TX
930.0 MHz	PCS	mobile TX
931.0 MHz	Land Mobile, Paging	base sta. TX
932.0 MHz	Fixed Microwave	low TX power
935.0 MHz	Mobile Data, SMR, Fixed Microwave	base sta. TX
940.0 MHz		

Figure 4. Familiarize yourself with the frequency assignments in the spectral vicinity of cellular. Sources of foreign interference are more likely to be high-output transmitters licensed to operate in the base station transmit bands.

begin the search in the 929MHz–930MHz one-way paging band. If the transmission pattern resembles that of a push-to-talk transmitter, search the land mobile base station transmit band between 851MHz and 869MHz. Continue to search upward and downward in frequency away from the cellular bands. Also, try dividing the frequency of the interferer by whole numbers, and tune to the resulting frequency to determine whether the interferer is a harmonic of some legitimate signal. Once you have found a signal that appears and disappears in unison with the interferer, attempt to demodulate it, and compare it to the spurious signal in your band. Your goal is to find an exact match.

Success with this simple comparison method relies on there being a one-to-one correspondence between the interferer and a legitimate signal, but what if the interfering signal comes as the result of transmitter intermodulation, i.e., a mix of two or more signals from different transmitters? Any number of combinations of transmit frequencies could result in an intermodulation product that would appear only when all transmitters involved are simultaneously keyed. Observing such an interferer in real time would be exceedingly difficult. The large test equipment manufacturers offer automated spectral monitoring systems to help in this work, but the problem of intermodulation remains complex.

Although transmitter intermod poses a challenging problem, rarely are radiated intermodulation products strong enough to cause serious interference to cellular signals. If you do encounter such a problem in your system, keep in mind that, regardless of the mechanism by which the intermodulation was created, the responsible entity still is the licensee of the one transmitter actually radiating the interfering signal. Radio direction-

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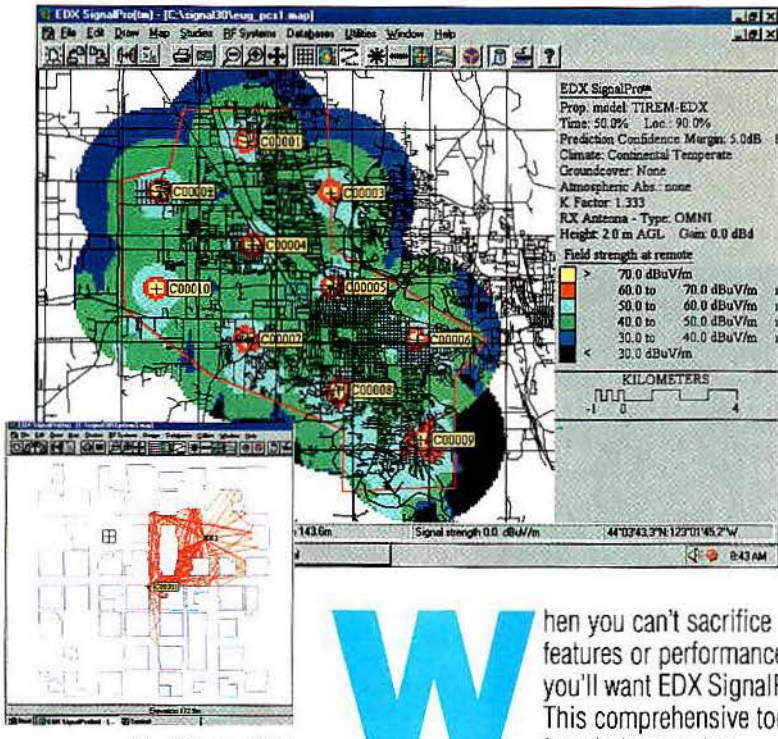

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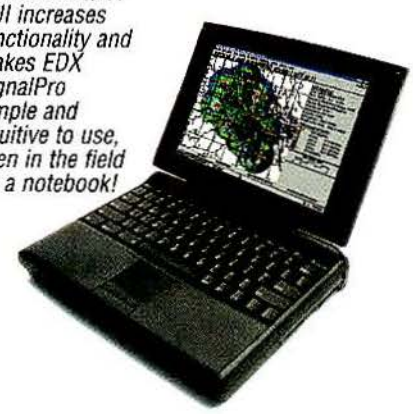

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finding may be the best means of tracking down such an interferer and, at the very least, it will narrow the list of candidates capable of producing the mix.

One more hint is worth considering in searching the radio spectrum. You should become familiar with other radio services licensed in the UHF band, especially those in the spectral vicinity of cellular. (See Figure 4 on page 58.) For this purpose, obtain a copy of the FCC rules found in Title 47 of the Code of Federal Regulations. Part 2 of the FCC rules contains the Table of Frequency Allocations, an extremely valuable list for identifying potential interferers. Other parts give specific frequency assignments for the various radio services and outline permissible levels for out-of-band emissions. You can purchase a copy by calling the Order and Information Desk of the Government Printing Office at 202-512-1800.

Once you are confident that you have identified the source of the foreign interference, call the FCC National Call Center at 888-FCC-TALK to obtain a point of contact for the suspected interfering station. Although the FCC generally does not have the manpower to conduct research or to hunt interferers, it still maintains the database of licensed transmitters that will help you in your efforts. Do not be shy about asking the FCC for assistance.

"Do the basic legwork first," advises Mike Ridder at the FCC. "Investigate as much as you can on your own, and have the important information ready, specifically, the operating frequency and approximate coordinates of the interfering licensee. We will gladly provide licensing information if it exists."

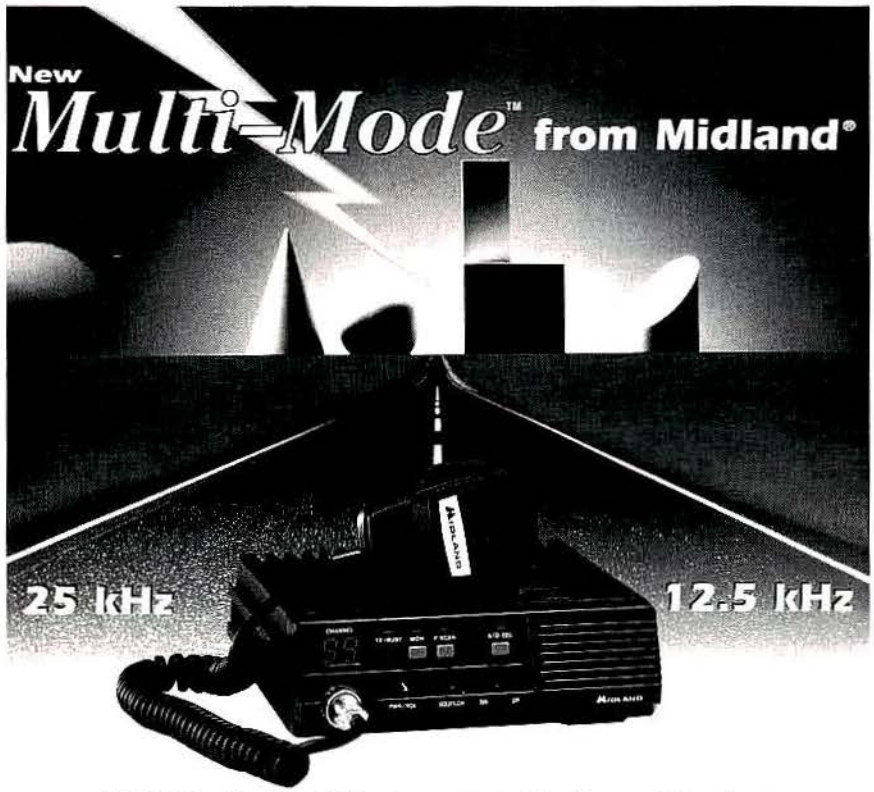
When you do contact the licensee of the suspected interfering station, be diplomatic. Identify yourself and your employer, and explain precisely why you believe that his transmitter is the cause of the problem. Be ready to describe the test methods that led you to this conclusion, and invite the licensee to an on-site demonstration of your test.

Almost every operator whom I have approached in these matters has been cooperative, professional and, in many cases, eager to resolve the problem. If, on the other hand, you encounter a system operator who is evasive, uncooperative or even unlicensed, then by all means inform the FCC, and be prepared to state your case and to present evidence. Bear in mind, though, that the law allows all transmitters to emit out-of-band emissions within specific limits, and even in cases of clear violations, the FCC generally prefers that the parties involved work out the problem among themselves.

The solution to the interference problem could come in the form of repairing faulty equipment; installing cavity filters, isolators or pre-selectors; repositioning antennas on shared towers; or in extreme cases, by re-channeling equipment. Almost every interference problem can be solved, once you have identified its source. The fact that so many different types of radio transmitters already share the spectrum and operate in a non-interfering manner should serve as an inspiration.

Tracking down and eliminating the source of foreign interference in the cellular band can be one of the most rewarding tasks you will perform, and the ability to do so will become increasingly important as the radio spectrum becomes more crowded. Always remember to be persistent, patient and, above all, diplomatic.

Happy hunting!



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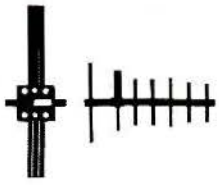

ANT940Y10-WR, also known as Yagi Antenna. born 6-24-74; 2.5 lbs; 24" x 9"; Known associates: likes to hang out in dingy, dismal areas. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted for directional control.

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TS4680, also known as Cross Band Coupler. born 2-10-86; size 6.6 x 1.5 x 0"; 1 lb; hvy const; 400 watts; blue finish; tower mountable. Wanted by tower operators for multiple transmissions of 450-860 equipment.

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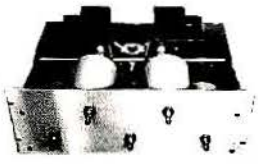

TC860, also known as Cellco Ceramic Trunking Combiner. born 5-25-91; size 7x19x14"; 36 lbs; rugged bld; 125 watts, alum finish. Wanted by SMR operators who want only the best.

PRINTS AVAILABLE

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ANT450D3, also known as Dipole Array Antenna. born 9-14-58; known associates: other antennas in other freq bands and gain. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted by tower operators with the worst possible problems.

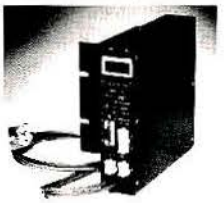
PRINTS AVAILABLE

Industry Top Ten Product

Model 44AP, also known as the Broadband RF Wattmeter. born 6-11-78; weight 4 lbs; rugged bld; 500 watts; gray comp; operates alone, no known associates; distinguishing marks: leather band on top, sample port right side. No known enemies, has been spotted worldwide.

R. Middle

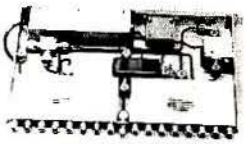
Industry Top Ten Product



PMU1C1S, also known as Power Monitor Unit. born 4-23-95; sml bld; blk, red eyes glow in dark. Wanted for monitoring ant VSWR and TX power. Notorious for working multiple freq in all bands. Known associates RS232 and RS485.

R. Index

Industry Top Ten Product



TWR816-860-1RTT, also known as Compact Receiver Panel. born 8-14-93; exceptional small build, likes to associate with multiple frequencies. Quiet 2.5 dB noise; modular; has been known to redundantly switch to 2nd channel if injured; likes living in harsh locations. Wanted for resisting interfering signals.

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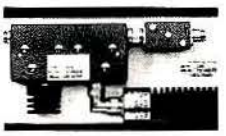

TS450PB1, also known as IM Suppression Panel. born 7-12-75; rugged bld; black & blue marks on body; 5 lbs; 19"x5.25"; 150 watts; 60 dB; wanted by transmitters for killing intermodulation; likes isolation. Reward is offered for protectionism.

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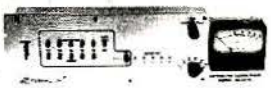

PM5C1S, also known as Automatic Alarm Panel. born 2-23-81; brushed alum; 1.4 lbs; 19"x3.5"; Known associates: likes to snitch on bad trans & ant; needs to be placed inline; violently resists high VSWR; likes power. Do not approach, will call you.

PRINTS AVAILABLE

Industry Top Ten Product

TATC8944, also known as Cellular Auto Tune Ceramic Combiner. born 4-1-92; size 10.25W x 10.75H x 12.75"; 36 lbs; heavy bld; black finish; easy to install. Wanted by Cellular operators for retrofit or new installations, both in USA and foreign countries.

L. Thumb

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Mobile antennas: Evolution

Predominant antenna types change as commercial users migrate to higher frequencies and adjust to spectrum availability, but technical refinements in antenna materials and manufacturing now focus on aesthetic considerations.

by D.A. Keckler

Expansion of commercial mobile radio use into higher frequencies, different applications and environments has meant a coincident evolution in the design, construction and placement of mobile antennas. The user no longer adjusts to the available equipment. Instead, it is a question of matching the equipment to the application.

Major technical innovation in antenna construction for land mobile and cellular use has pretty much reached a plateau, although behind the scenes there is constant improvement in range testing to meet targeted specifications. Frequencies have gotten higher, and antennas have gotten shorter. Although there has been some flirtation in recent years with serpentine arrays, patches, helixes, ring radiators and other antenna types, the mast, in one form or another, seems here to stay. Technology has become more finely tuned, so manufacturers are looking at aesthetics. Like champion pidgeon breeders, antenna makers are all dealing with the same basic bird, but each strives for a unique mixture of color and feathering.

The choices facing the user are selecting an antenna appropriate to the frequency *and* application, and taking advantage of available embellishments that significantly improve communications system performance.

Gain

The most basic antenna for mobile use is a quarterwave vertical antenna with an omnidirectional pattern. Its gain is the same as a dipole, 0dBd (or about 2.1dBi).

It should be pointed out that cross-comparisons among different antenna makes should not be taken at face value, because the apparent gain may be higher than the desired reference. When determining antenna suitability for a particular application or topography, check the reference for the antenna gain as quoted by the manufacturer. Most cellular antennas, for example, offer 3dB gain compared to a reference halfwave dipole (3dBd), which is the best comparison and was the original AMPS industry standard. Comparisons to a quarterwave ground plane or to an isotropic antenna (dBi) are less-telling. A "5dB gain antenna" may be referenced to a dipole, but if the reference is to an isotropic antenna, the gain is actually 2.85dBd.

Gain has tradeoffs. As gain increases, the beamwidth decreases, but less power is required at the transmitter. A high-gain mobile antenna directs the radiation pattern vertically, concentrating energy toward the horizon (making it suitable for Kansas, but not downtown Chicago).

Gain of 3dB is adequate for general mobile use. Higher gain does not enhance the reception level (and the total amount of energy radiated from the antenna does not increase). Moreover, the elevation level for scattered signals in cities with tall vertical structures is higher than in suburban or rural areas.

Antenna types

A mobile antenna should be omnidirectional and, ideally, mounted at the vehicle's highest point, the roof, to obtain clear reception. A roof-mounted 3dB collinear antenna will provide a better pattern than a single-element quarterwave antenna. A glass-mount antenna produces a pattern roughly equivalent to a roof-mounted quarterwave antenna in free space.

When a quarterwave vertical element is mounted on metal roof, the roof acts as a ground plane, creating a "mirror image" forming the complement of a halfwave dipole with an omnidirectional pattern. Non-metallic roofing (vinyl, composite, or fiberglass) disqualifies the roof as a site. Placing the quarterwave elsewhere, such as a fender or bumper will distort the horizontal pattern and increase the directionality of the gain.

Low-band VHF (25.01MHz–49.6MHz) for land mobile uses a quarterwave whip, usually a base-loaded antenna with a coil that reduces the mast requirements to about four feet.

High-band VHF (150.8MHz–173.4MHz) also uses a quarterwave antenna, which at 150MHz is about 1.5 feet tall. Halfwave and 5/8-wave antennas with 3dB gain are also used (with a coil to match impedance to the receiver anntenna input).

UHF (450MHz–512MHz) requires a quarterwave about 7" tall. Collinear UHF antennas use two 5/8-wave elements joined by a phasing coil and have about 5dB gain.

Antennas for the 800/900MHz band (806MHz–940MHz for land mobile) are generally either unity-gain quarterwaves or 3dB-gain collinear antennas combining a 5/8-wavelength element, a phasing coil and a quarterwave element.

Glass-mount antennas are indisputably the most popular cellular antenna, because they avoid marring a vehicle with a hole and the attendant problem of corrosion. Common configurations are a vertical halfwave element collinear with another halfwave, or a vertical 5/8-wave element collinear with a quarterwave; in both cases a phasing coil connects the two vertical elements and keeps the RF energy in phase.

For PCS applications at 2.2GHz–2.9GHz, factory-tuned antennas offer about 100MHz bandwidth at 3dB gain or 75MHz bandwidth at 5dB gain, with a VSWR of about 1.5:1.

Refinements

The following is a partial list of improvements and equipment options for mobile antennas introduced in recent years ("from the ground up," so to speak):

▶ *Ground planes* — Magnetic-mount antennas for cellular and PCS are available with integral ground planes imposed at the feedpoint to overcome ground decoupling at higher frequencies.

▶ *Cabling* — Improvements in feeder cables include low-loss, braided cables.

Keckler is features editor.

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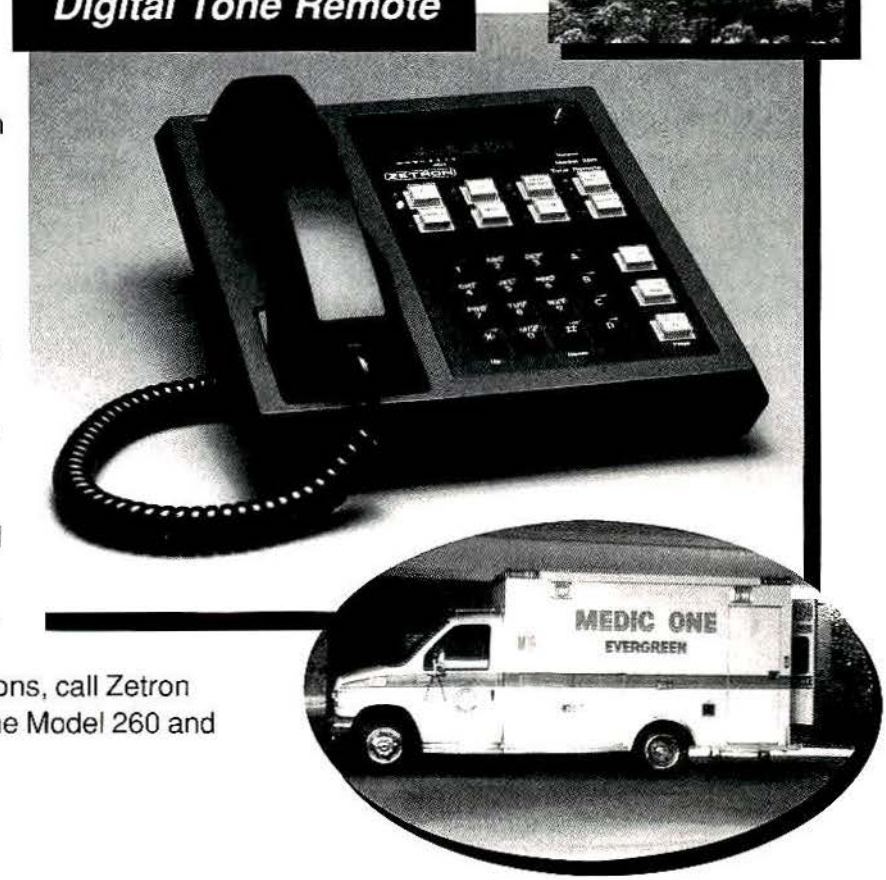

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Even corrugated cables now have a greater degree of flexibility. Lower surface current on cabling minimizes weak signals and prevents the escape of RF signals that might interfere with vehicle electronics or engine diagnostic computers.

▶ *Mounts* — For body-mounted antennas, shielded mounts decrease interior radiation and reduce noise compared to open-junction mounts. Coatings are now being used on base springs to avoid noise generation from the coil. Durable materials such as Neoprene are being used in seals and gaskets to avoid moisture intrusion into the vehicle body and into antenna coils.

Automobile styles continue to be more aerodynamic, so for glass-mount antennas, flexible plastic bases are being used that conform to the concavity of windshields and windows. Improved adhesive formulations for stickers and tapes hold antennas more securely.

Fold-over hinges and swivels for both body-mounted and glass-mounted antennas accommodate hatchback body styles, car washes and low overhead clearances.

Cellular phone use is no longer vehicle-dependent. Available to the mobile worker are several couplers and temporary antennas (primarily window-clip and magnetic versions) to augment use of a portable cellphone when using a rental vehicle on location. Vinyl-coated clips avoid damage to glass. Applicable to SMR, cellular AMPS or GSM, the antennas can be obtained in unity, 3dBd and 5dBd versions with open or enclosed coils.

▶ *Multiplexing* — Duplexers and triplexers are available with insertion losses ranging from 0.1dB to 0.4dB. Triband mobile antennas, resembling elevated feed antennas, can serve UHF, VHF and cellular frequencies.

▶ *Couplers* — Non-mechanical, solid-state coupling boxes for glass-mount antennas straddle window defogger wires.

▶ *Loading coils* — Loading coils can be obtained with chroming for durability. (Likewise, brass fittings provide durability and resistance to corrosion.)

▶ *Phasing coils* — UV-resistant materials are being used for many antenna parts, including non-fade housings for phasing coils. The materials also deter corrosion.

Wind noise aesthetics for coil enclosures have led to straking, or channels, that direct wind more efficiently around the mast and eliminate whistling.

▶ *Whips and masts* — Solid encasing or sheathing of whips (in plastic, composites or polycarbonates) reduces noise and the build-up of static charges.

Antennas can get taller—with high masts now being stocked to accommodate sport utility vehicle and truck installations where more height is required to clear the roof line, or shorter—with low-profile, three-inch globe and spike glass-mount antennas for cellular use.

Broadband disguised antennas, or AM-FM "look-alikes," with 125MHz bandwidths, are available for surveillance work requiring inconspicuous vehicles.

▶ *Modularity* — Interchangeble base coils, springs and whips allow quick replacement or modification for migrating to a different frequency. Inventory space can be reduced as well with modular systems.

The antenna is, paradoxically, the least expensive and most important component in a mobile system. The sophistication of a mobile radio system is irrelevevant if there is a problem at the first point of reception and last point of transmission: the antenna.

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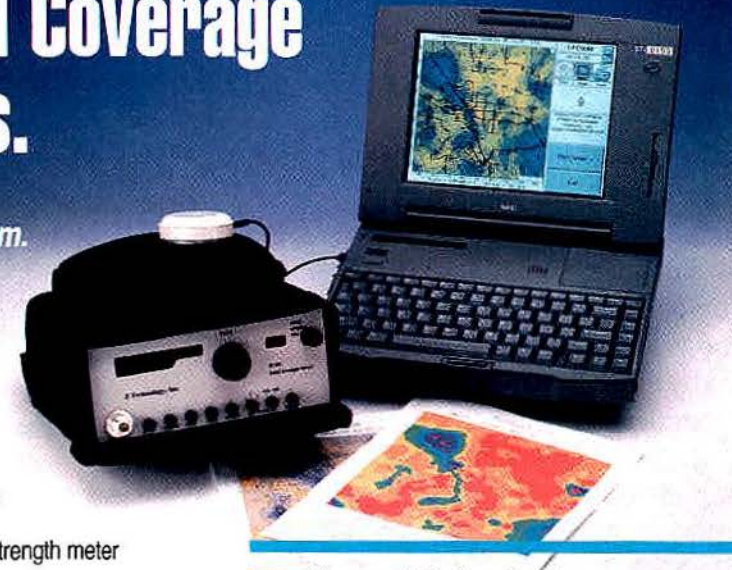

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Helicopter operations for service technicians

As communications sites become more remote, helicopters may become as commonplace for installation, service and maintenance trips as panel trucks. Learn how to use this means of transportation to your customer's advantage.

By Mark A. Ewing

Most of today's field technicians will have at least one, if not many, opportunities to experience helicopter transportation.

First-timers can use the following information to appear at least somewhat "helicopter-literate." It also gives some insight on proper safety procedures.

In Alaska, as in many other places with abundant mountains, mountaintops make fine platforms for linking modern telecommunications systems. As the "drive-up" locations fill to capacity, and as intermodulation interference (intermod) becomes more prevalent, many system engineers look for communications site locations with better isolation.

The helicopter plays a valuable role in locating potential sites, making a proper site survey, mobilizing the site equipment and providing continual access to the site for service and maintenance. Because most of these sites have buildings, towers and guy wires, the amount of maneuvering area available to a pilot normally is somewhat limited. This restriction can put you, the field technician, in a precarious position if it makes loading and unloading the helicopter more difficult.

No matter where you load a helicopter, whether on a building, an oil drilling platform, a parking lot or the airport tarmac, safety always should be the main concern. If you load the equipment at the airport, the pilot or co-pilot must accompany you upon entering the airstrip. You may need proper clearance and identification attached to any vehicle used to transport equipment to the helicopter. Most helicopter operators require the pilot or co-pilot to ride along with you when transporting anything to the helicopter.

Before loading equipment, tools or other items, keep in mind that helicopters are made primarily of aluminum. They dent easily, especially from the inside. It is not advisable to sling your toolbox up to any old spit; rather, it is better to consult the pilot on a location. Even better, he may want to load the gear for you! It can be fun watching someone else struggle with your tool cases. Any lengthy items, such as an antenna mast, lumber and shovels, must be carried to and from the helicopter in a *horizontal position*—a good practice even when the helicopter's engine is shut down.

The helicopter plays a valuable role in locating potential sites, making a proper site survey, mobilizing the site equipment and providing continual access to the site for service and maintenance.

If possible, talk for a few minutes with your pilot. Find out what requirements he may have or what he may expect from you. Every pilot has different requirements, so pay close attention. Pilots are skilled professionals with a job to do. Never treat them like a taxi driver. Adverse treatment will only make it hard on the next engineer or technician—and that person may even be you.

Sometimes there may be no opportunity to talk with the pilot before loading. You may have to load the helicopter at a remote location, while the rotor blades are still turning, a condition referred to as *loading hot*. Before the helicopter arrives, take a few minutes to secure your gear, and weight down any light boxes, extra coats or loose materials. Many times I use my tool cases for weight. Inspect the landing area for anything light, such as pieces of plywood, two-by-fours, sticks, lengths of rope or tarps, and secure them. The helicopter's downwash can move heavy sheets of plywood with ease, so do not underestimate the power of the rotor blades.

Something as harmless-looking as a plastic bag can be sucked up by the rotor blades, hitting either a blade's leading edge and causing a ding where most of the integrity of the blade is, or entering the air intake system to be sucked into the engine. The result could range from not flying that aircraft that day to injury or loss of life. The cost of damage to the helicopter might be billed to the customer or to you. Always take a few minutes to police the landing area before the helicopter arrives.

Always approach the helicopter from the front, and only the front. If possible, let the rotors come to a complete stop, unless for some reason shutting down the engine is not possible. Never approach the aircraft from an uphill angle where the terrain is not level. After arriving at the front, determine whether you will load from the left or right side. Most of the time, the pilot will signal you to the side he prefers for loading. Pay close attention to his hand signals if you are loading hot.

The pilot is in charge at all times when it comes to anything that may

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affect helicopter operations. He decides whether the weather is satisfactory for flying and whether a site is suitable for landing. Never attempt to push the pilot into an uncomfortable situation. He is ultimately responsible for any actions regarding his aircraft.

Danger zone

The tail rotor has always been the most dangerous element in any helicopter operation. Most pre-flight deaths involving helicopters can be attributed to the tail rotor. A vital system in the helicopter, the tail rotor counteracts the rotational force applied by the main rotor to the ship's airframe. The tail rotor keeps the helicopter's cabin from spinning with the main rotor. Unfortunately, the tail rotor has been an instrument of death to almost everyone who finds himself too close to it. It spins at three times the speed of the main rotor, so fast that the human eye cannot see it. Most pilots get extremely nervous if you venture too close to the rear of the aircraft. They are likely to take a few minutes to let you know about it, quite possibly in front of your customer. In all the years I've been flying in helicopters, I have never heard it explained to anyone at a volume less than 90db. *"Stay away from the rear of the helicopter."*

Some helicopters that operate over or near large bodies of water are fitted with inflatable flotation devices mounted either on the side of the cabin or on the landing skids. Be careful when loading equipment or passengers not step on or otherwise make contact with these floats. Aircraft with floats normally incorporate a emergency window evacuation system to allow you to exit the aircraft without damaging the floats in the event of a water landing.

Never attempt to push the pilot into an uncomfortable situation. He is ultimately responsible for any actions regarding his aircraft.

Pre-flight

The pilot will give you a quick preflight overview before take-off. You will be shown the emergency features available on that aircraft, along with the location of the emergency locator transmitter (ELT). The emergency evacuation procedures will be explained. Pay close attention to what is being said; you may need that information some day—maybe even *that* day.

Take-off

The time has come to fasten your seat belt. Your tools and equipment are secure, your door is completely shut, and you have remembered everything—except the restroom. Another 90db talk from the pilot? Let's hope not. But while we are on the subject, remember to carry a few heavy trash bags when you fly to remote locations, because restrooms and helicopters seldom see much of each other. Be prepared to pack out *everything*

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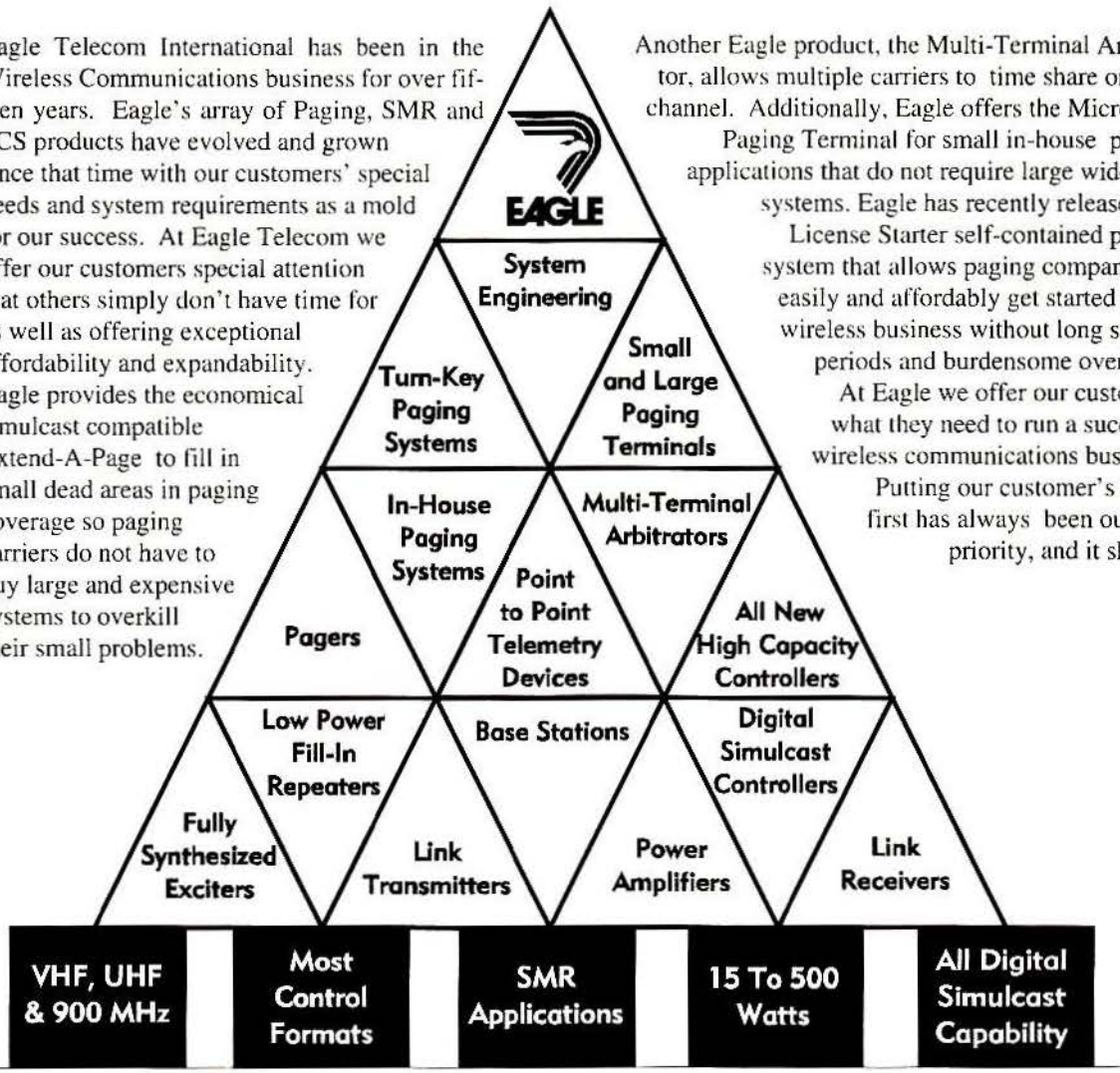

Another Eagle product, the Multi-Terminal Arbitrator, allows multiple carriers to time share one RF channel. Additionally, Eagle offers the Microbeep Paging Terminal for small in-house paging applications that do not require large wide area systems. Eagle has recently released the License Starter self-contained paging system that allows paging companies to easily and affordably get started in the wireless business without long startup periods and burdensome overhead. At Eagle we offer our customers what they need to run a succesful wireless communications business. Putting our customer's needs first has always been our top priority, and it shows!

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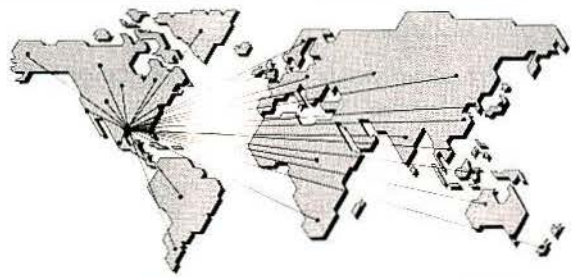

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you have packed in, including boxes and equipment packing. Never burn refuse at a remote location. Following these guidelines will help to keep the environment friendly and, most important, the customer happy.

Most mountaintops are owned by the state or federal government. Access is allowed by permit. These locations are continually monitored for infractions that could result in the permit being revoked.

With the sound of the turbines whining, the whop of the main rotor gaining speed, you lift off. Never distract the pilot during take-off or landing. These maneuvers require full concentration. The pilot has good visibility to the sides and the front of the aircraft, but some blind spots remain to the rear of the helicopter. During flight, if you spot another aircraft approaching from the rear, you might point it out to the pilot. The best way to inform the flight crew of other air traffic is over the intercom, if there are extra headsets available, or you may want to hand the pilot a note. Never do this in a way that may create a panic, normally there is plenty of time for the pilot to react.

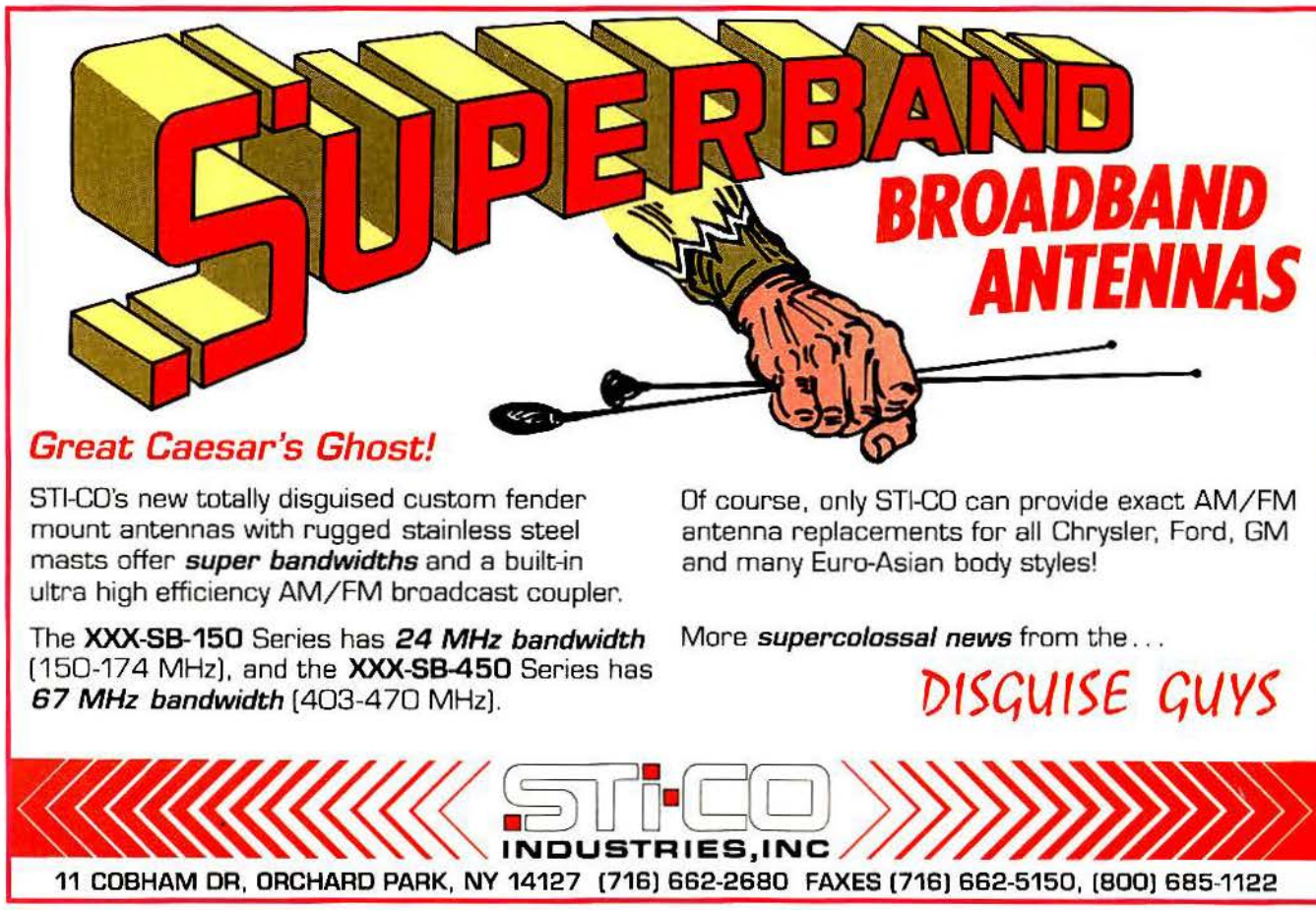
It is hoped that the pilot is familiar with your destination. Always bring your own coordinates just in case, especially if it is a mountaintop site. Now is the time to pull out your new camera and take all those aerial photos you have always wanted to take but that you could not take because you could not afford to pay for a helicopter ride. Helicopter time is expensive, so use it efficiently.

Helicopter transportation is safer travel than driving a car. The navigation and safety systems are the best available, and maintenance is an ongoing process carried out by highly skilled professionals. All of the pilots I have encountered are level-minded and safety-conscious. Trust their judgment. During the flight is a perfect time to relax. (This is normally when I have a chance to indulge in my latest copy of *Mobile Radio Technology* or to catch up on lost sleep.)

Landing

When you reach your destination, be it a heliport on an oil-drilling rig, a mountaintop, the top of a building or the airport, check the aircraft interior before departing to ensure that you have everything you brought with you, including any trash created during the flight. If conditions permit it, the pilot will shut the engine down and bring the rotors to a complete stop before you depart the aircraft. At times, high winds or a small landing area will force you to unload your equipment and tools and disembark with the rotors still turning. Remember to exit toward the front of the aircraft, staying clear of the danger zones. The helicopter may need to be repositioned to a nearby location where the engine can be shut down safely. I always carry an aviation hand-held transceiver to help in arranging the departure. A prearranged pickup time also works, but you must be on the lookout for declining weather conditions that may change your departure plans.

Follow the reverse procedures for offloading the aircraft. The pilot should be eager to allow you to unload your own tools. Check to be sure that the aircraft is left clean. Attention to small matters such a these can be a direct reflection on the quality of your work.



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IT'S A SCIENTIFICALLY PROVEN FACT...

If you use a noise attenuating headset with your two-way radio, you're not getting the whole message.

Two-way radio communications in the presence of noise can be difficult. While conventional noise attenuating headsets can help, they are not necessarily your most effective choice. These headsets attenuate noise using only passive dampening techniques. They cannot guard you against the low frequency noise that penetrates the earmuff itself and causes a scientifically-proven phenomenon knows as *"the upward spread of masking"*.

This effect means that in the presence of low frequency noise you will find it difficult to hear speech communications. Even more important, however, *you will have trouble understanding the meaning of what you hear*. Your most effective choice for intelligible communications is a noise attenuating headset that incorporates "active" noise reduction technology. "Active" noise attenuating headsets are different. These headsets cancel noise electronically *before* the noise reaches your ear; and *before* it interferes with your ability to understand what is being said to you.

Upward spread of masking--deadly to intelligibility

Researchers have demonstrated that the ability to understand speech is progressively degraded as noise becomes more intense, and *particularly when the noise is increasingly dominated by low frequency energy*. That means that as the intensity of low frequency sound increases, it is accompanied by a disproportionate degradation in your ability to perceive the high frequency sounds that carry the meaning of speech. The greater the intensity of the low frequency noise, the higher the frequencies that are adversely affected.

The meaning of speech is carried by the consonant sounds, which are much softer in level and higher in frequency than vowels. That means they are easily masked by low frequency noise.

You need not only to hear but to understand radio communications, which means making the volume sufficiently loud to hear the soft consonant sounds. However, the volume needs to be turned up even higher in order to override the effects of low frequency masking, at which point the sound becomes distorted. This distortion occurs not only in the output of the speaker, but also in your ear, which is overdriven at high sound levels. The result is that you have not only *distorted the communications you are trying to understand* but you have amplified your signal to a level that may *damage your hearing*.

As you are probably aware, the more noise you are exposed to, the longer period of rest your ears require to recover from threshold shifts in hearing (TTS), thereby helping to prevent the build-up of permanent hearing loss. Research shows that exposure to *low frequency noise requires a longer recovery period.*

Low frequency noise penetrates concrete walls

Low frequency noise is most typically produced by mechanical devices such as engines, motors, generators and fans. The waves created are very long, very powerful and can travel great distances. In fact, the tremendous sound energy enables these waves to easily penetrate passive noise barriers—*even concrete walls!* In the presence of these giants, your shorter and weaker voice signal waves are lost.

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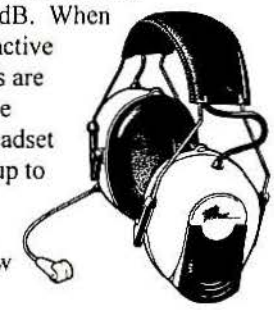
The **ProActive** is the only active headset that has been specifically designed to provide better intelligibility of communications and hearing protection in general industrial settings. **ProActive's** passive noise reduction rating (NRR) is 21 dB. When passive and active performances are combined, the ProActive headset can achieve up to 35 dB of noise reduction at the low frequencies.



While active noise cancellation headsets have been used by the military and by aviation pilots for decades, this is the first time this powerful technology has been made widely available and affordable.

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Paging system migration from one technology to another

A system designer must show how either a new system or an old system will handle a "pure," single format or mixed paging formats and mixed message types.

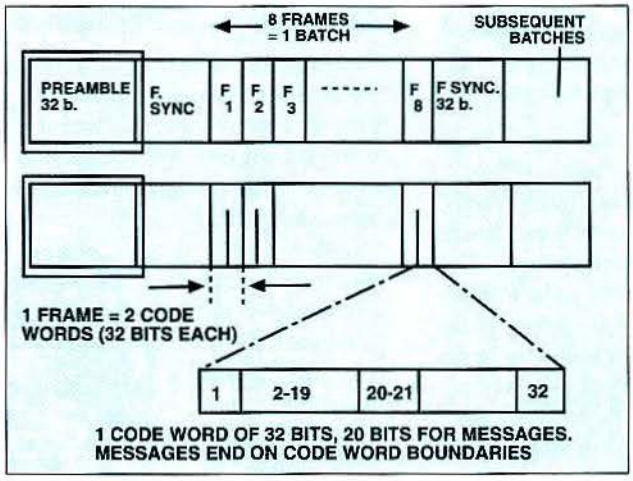

Figure 1. POCSAG code format.

Table 1—POCSAG format summary			
	512	1200	2400
Preamble length	1.125 sec	0.480 sec	0.240 sec
Warmup time	0.4 sec	0.2 sec	0.1 sec
Batch length	1.0625 sec	0.4533 sec	0.2267 sec
Event length (30 batches without warmup	33 sec	14.08 sec	7.04 sec
Number of events/hour ignore warmup	109	255	511
Codewords/batch	16	16	16
Codewords/event	480	480	480
Available code words/hour	52,320	122,400	245,280

Table 2—Required codewords.			
POCSAG	Tone	Numeric 10-digit	Alphanumeric 40-character
Required codewords	1	3	15

Table 3—Number of pages per batch.			
	POCSAG 512	POCSAG 1200	POCSAG 2400
Tone	16	16	16
10 digits Numeric	5	5	5
40-character alphanumeric	1	1	1
Batch length in ms	1,062.5ms	453.3ms	226.7ms

By Sarwat Tawfik

When paging systems migrate to a new technology, the system designer has to consider how to mix the new format with the current format. System specifications include system capacity (number of users), unused time and system loading. Variations include the use of all system transmitters at once, as in a simulcast system, or the selection of individual transmitters, as in a two-way paging system. A paging system could include only one type of paging message via one protocol; it could mix page types on single format; it could mix more than one format serving one type of page; or it could mix several types of pages to be carried on more than one format.

The paging formats (and transmission speeds in bits per second [bps]) include Golay sequential code (GSC) (300bps, 600bps), POCSAG (512bps, 1,200bps, 2,400bps), Flex (1,600bps, 3,200bps, 6,400bps) and European Radio Message System (ERMES) (6,250bps). These formats have different message types and lengths of tone-only, 10-digit numeric and 40-character alphanumeric. We assume that mixed paging formats are sharing one or several encoders within one paging terminal (paging switch) that feeds one RF transmitter. No assumptions are made regarding the features of traffic store-and-forward, priority schemes, users' group calls or multiple messages calls. The designer has to know the specific variable operating characteristics (such as call user hour and number of offered users) for each format before making the calculations.

Paging formats

▶ *POCSAG* — With respect to POCSAG, one preamble for every 30 batches (one event) is an assumed average. For 512bps, the preamble length is 1.125sec and batch length is 1.0625sec, including sync. One event of 30 batches takes 33 seconds (1.125 + 30 × 1.0625); i.e. in one hour, there are 109 events (3,600÷33), which result in 52,320 (109 × [30 × 8 × 2]) code words/hour. For 1,200bps, preamble length is 0.48sec; batch length is 0.4533sec; one event is 14.08sec; 255 events result in 122,400 (255 × 480) code words/hour.

The "F. Sync" is a synchronization frame (takes one code word), and it precedes every batch. (See Figure 1 above left.) The code word of 32 bits may be used for address or message data. The difference between address and message code words is that there are 19 address bits in the address code word,

Tawfik is consultant engineer at Mobile Systems International, Oakbrook Terrace, IL, and London.

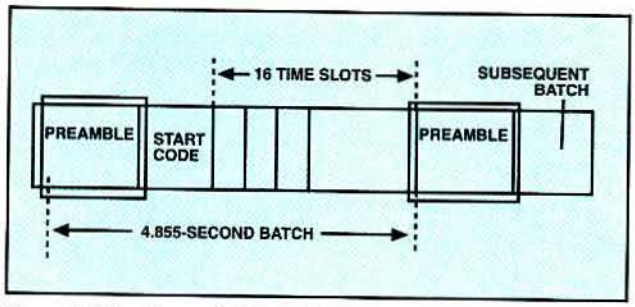

Figure 2. Golay Sequential Code (GSC) format.

starting with "0" (they start with "1" in the message code word), and bits 20 and 21 carry the source identifier (they are added to the 19 bits in message code words); 20 bits will be used for user message data. The last 11 bits on both code words (bit 22 to bit 32) are for even parity check. Messages must end on code word boundaries. The synchronization and the idle code words have a unique address code word.

Table 1 on page 72 summarizes the POCSAG paging code format. The warmup time usually is needed when two different formats are used to allow the encoder to combine two different formats or to switch from one to another. The warmup time precedes the first batch of the different format, and it has been ignored in calculating the batch length and number of events for a fully loaded POCSAG system. Table 2 on page 72 gives the required code words, and Table 3 on page 72 lists the number of pages per batch.

▶ *GSC* — In the standard GSC, the start code repeats for every batch (every 4.855 seconds). (See Figure 2 above.) In the extended GSC, the start code period repeats for as many as eight batches of start code and 16 messaging time slots, i.e., for as long as an 8 × 4.855 = 28.85-second interval. Each time slot serves a paging message. Messages end on time slot boundaries.

▶ *Flex* — As shown in Figure 3 on page 74, the first code word in block 0 (B0) is for system information only, i.e., 87 code words at 1,600 bps in each frame for user message data. The available speeds in Flex code are 1,600bps, 3,200bps and 6,400bps. The higher speeds of 3,200bps or 6,400bps are achieved by multiplexing two or four of the 1,600bps traffic subchannels (sometimes called *phases*) by interleaving 8, 16 or 32 blocks of 32 bits coded by Bose-Chadhuri-Hocquenghem (BCH) (32,21) coding interleaved at depth of eight. The available code words per frame are 87 at 1,600bps, 174 at 3,200bps and 348 at 6,400bps. The digital modulation used is 2-level frequency-shift keying (FSK) for 1.600bps and 3,200bps and 4-level FSK for 6,400bps.

The available frames/hour = 3,600÷1.875 = 1,920 (independent of the speed).

A summary of the Flex coding structure appears in Table 4 on page 74. Table 5 on page 74 gives the required code words, and Table 6 on page 74 lists the number of pages per Flex frame.

The number of pages/Flex frame

= floor(frame length ÷ message length)

or

= floor(frame code words ÷ required code words/page)

The number of pages per frame is independent of the Call User Hour (CUH) of the page type, but it depends on the

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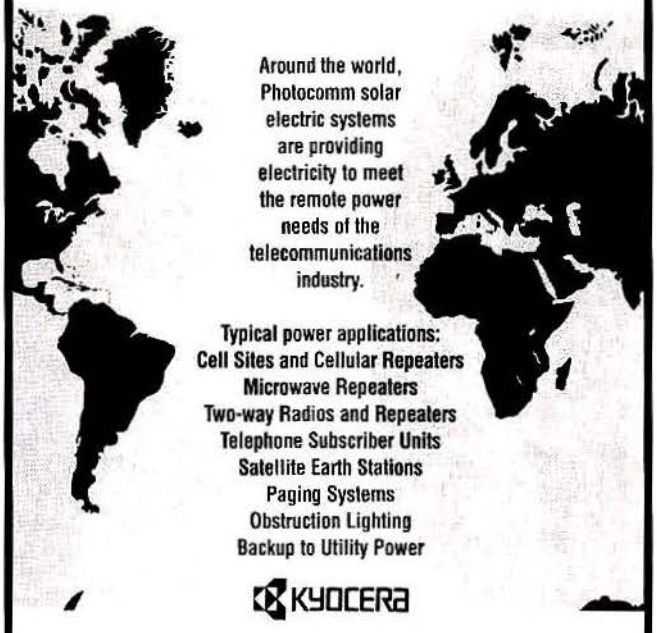

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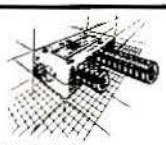

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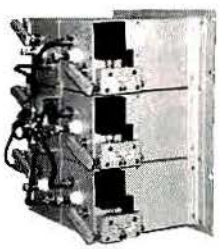

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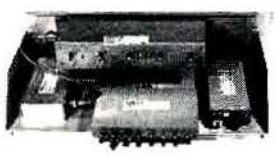

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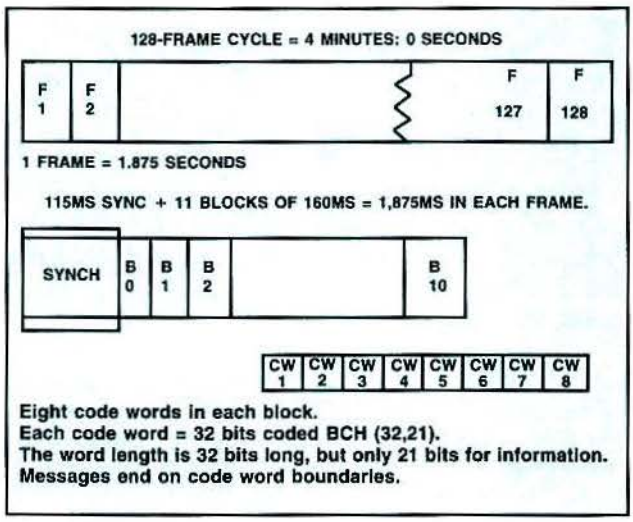

Figure 3. Flex code format.

Table 4—Flex coding structure summary.

Frame structure	Flex 1600	Flex 3200	Flex 6400
Sync + 11 data blocks length	1.875sec.	1.875sec.	1.875sec.
11 blocks length	1.76sec.	1.76sec.	1.76sec.
Sync length	0.115sec.	0.115sec.	0.115sec.
Code words (32 bits)/block	8	16	32
Available code words/frame	(8 × 11) − 1 = 87	174	348
Available frames/hour	3,600 ÷ 1.875 = 1,920	1,920	1,920
Available code words/hour	167,040	334,080	668,160

Table 5—Required code words/page summary.

	Tone	Numeric 10-digit	Alphanumeric 40-character
Flex format	2	4	17
POCSAG format	1	3	15

Table 6—Number of pages/Flex frame (of 1,875ms).

	Flex 1600	Flex 3200	Flex 6400
Tone	43	87	174
10 digits numeric	21	43	87
40-character alphanumeric	5	10	20

transmission speed.

When Flex format is mixed with any other paging format, a minimum of one frame should be transmitted every minute. The collapse value of 0,1,2,3,4 determines a number of 1, 2, 4, 8, or 16 active Flex frames per minute.

▶ *ERMES* — Figure 4 on page 75 describes the ERMES code format. There is only one signaling speed of 6,250bps in ERMES. The total number of batches/hour is = 60 × 5 × 16 = 4,800 batches of 750msec each. Table 7 on page 75 lists the paging types.

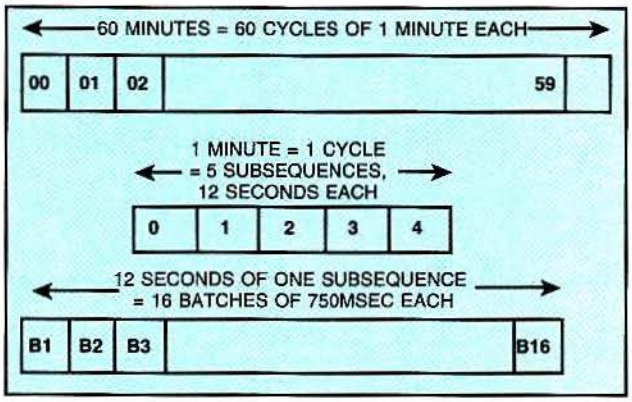

Figure 4. ERMES code format.

Table 7—ERMES paging types.

Page type	User hour	Message length	Pages/ batch	System capacity
Tone	181,500	19.83	37	1,210,000 @ 0.15
10-digits numeric	103,725	34.7	21	414,900 @ 0.25
40-character alphanumeric	36,300	99.17	7	121,000 @ 0.3

The user hour = system capacity * CUH

The Message length in seconds

= 3,600 ÷ 181,500 for tone

= 3,600 ÷ 103,72 for numeric

= 3,600 ÷ 36,300 for alphanumeric

System loading

▶ *User Hour* — The User Hour for each paging type, format and transmission speed is the number of pages that could be delivered in one hour when CUH = 1. The User Hour for each paging type, format and transmission speed is different because of the difference in the total number of available code words per hour and the required number of code words for each page type under each format. For example, the total available code words per hour for POCSAG 512 format is 52,320 code words [(3,600÷33) × 30 × 16). The required code words for tone, 10-digit numeric and 40-character alphanumeric pages are one, three and 15 code words respectively. In Flex format, the required code words are two, four and 17 respectively. The required number of code words for a page type will not change by transmission speed as the total available code words do.

The User Hour

= (total available code words/hr) ÷ required code words

or

= Total system capacity × CUH

The average time needed for one page message = 3,600 ÷ the total user hour. See Tables 8 and 9 on page 76.

▶ *System capacity* — Here are four system operating conditions under which system capacity differs:

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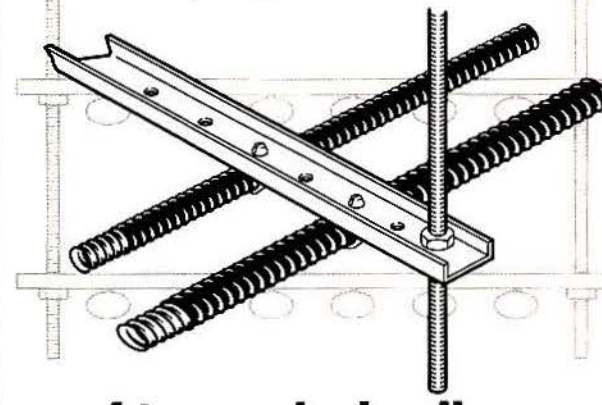

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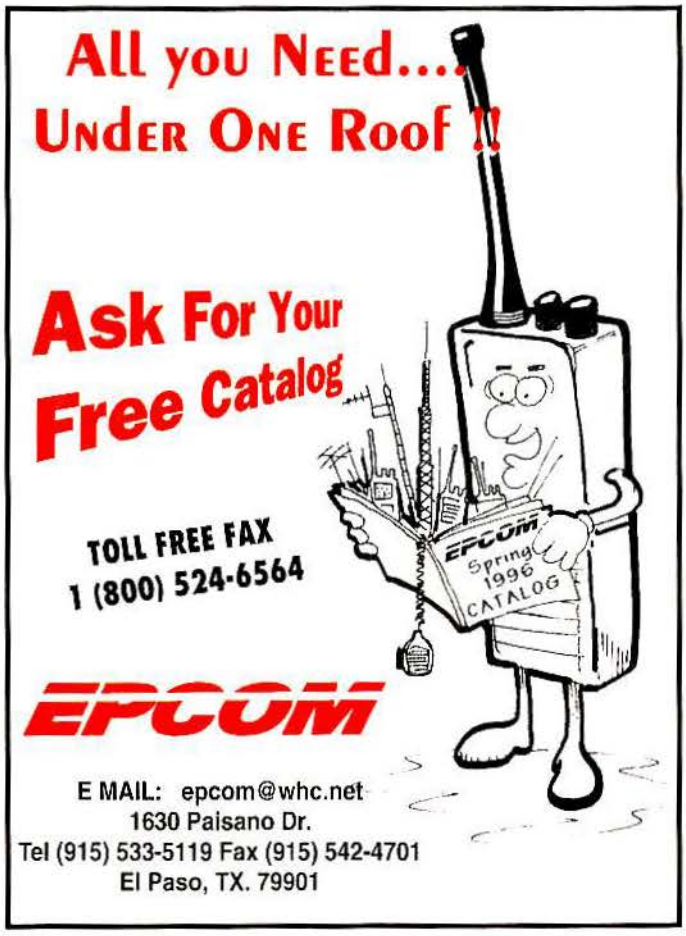

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Table 8—Total user hours at 100% system efficiency.							
Page type	POCSAG 512bps	POCSAG 1200	POCSAG 2400	Flex 1600	Flex 3200	Flex 6400	ERMES 6250
Tone at 0.154 CUH	52,320	122,400	245,280	83,520	167,040	334,080	181,500
Numeric (10 digits) at 0.25 CUH	17,450	40,800	81,750	41,760	83,525	167,050	103,725
Alphanumeric (40 char.) at 0.3 CUH	3,480	8,160	16,350	11,340	19,650	39,300	36,300

Table 9—Average message time in msec at 100% system efficiency.							
Page type	POCSAG 512bps	POCSAG 1200	POCSAG 2400	Flex 1600	Flex 3200	Flex 6400	ERMES 6250
Tone	68.8ms	29.41	14.68	43.10	21.55	10.77	19.83
Numeric (10 digits)	106.3ms	88.23	44.04	86.21	43.10	21.55	34.70
Alphanumeric (40 char.)	1,034ms	441.18	220.18	317.46	183.21	91.60	99.17

- ☐ non-mixed system.
- ☐ mixed page types using the same format.
- ☐ mixed format types using the same page types.

As a rule of thumb, if the call rate of the user of a page type is x calls per hour "CUH," then the system capacity (number of users served) = the User Hour of that page type ÷ x. Another way to define the system capacity is to divide the total available code words by the product of the required code word for a page type and its corresponding *call user hour* (CUH).

Non-mixed system. Table 10 on page 77 reflects a single-format, single-page-type (tone-only at .15 CUH, 10-digit numeric at .25 CUH or 40-character alphanumeric at .3 CUH) and 100% system efficiency.

The system capacity numbers in the table match the published numbers claimed by each standard authority body.

Mixed page types system. Table 11 on page 77 reflects system capacity when different page types are mixed using one encoder of one format. The table shows only one example with certain ratios of each page type (10% tone-only at CUH 0.15, 70% 10-digit numeric at 0.25 CUH and 20% 40-character alphanumeric at 0.3 CUH)

The total system capacity in each format = floor(3,600 ÷ [Σ(message time in milliseconds × CUH × page type traffic ratio) ÷ 1,000)]).

The page type user = page type percentage × system capacity.

These same formulas are used for any other mixing ratios.

The total system capacity numbers for POCSAG format in the mixed-page-types system capacity table (Table 6) match published numbers for that particular test case of mixed traffic ratios as released by Motorola in April 1994. The same formulas are used for the other formats as well.

Mixed format systems. This information is intended to help you to visualize how the system will migrate from one format, such as POCSAG, to Flex or ERMES. Mixing different formats will be based on the frame length (not the message length), and the minimum number of inserted frames is *one* per minute. Normally, at the beginning of migration, the old format is predominately loading the system with a higher percentage of traffic. Certain assumptions must be made by the designer for the Flex collapse value parameter before analysis.

The designer has to allow about 100msec of unused time for the nominal encoder delay to switch from one format to another or to combine two formats in a transmission frame in the paging terminal. Because the insertion of Flex code format will be

Table 10—Non-mixed system capacity (in thousands).

Page type	POCSAG 512bps	POCSAG 1200	POCSAG 2400	Flex 1600	Flex 3200	Flex 6400	ERMES 6250
Tone at CUH = 0.15	348.8	816.0	1,635.2	556.8	1,113.6	2,227.2	1,210.0
Numeric 10 digit CUH = 0.25	69.8	163.2	327.0	167.0	334.1	668.2	414.9
Alphanumeric 40 char. CUH = 0.30	11.6	27.2	54.5	37.8	65.5	131.0	121.0

Each entry value in the above non-mixed system capacity table = the corresponding user hour ÷ the call user hour (CUH).

Table 11—Mixed page type system capacity analysis at (10% tone, 70% numeric, 20% alphanumeric.

Page type	POCSAG 512	POCSAG 1200	POCSAG 2400	Flex 1600	Flex 3200	Flex 6400	ERMES 6250
Tone, CUH = 0.15	3,630 users	8,500	17,030	10,350	19,090	38,181	29,221
Numeric 10 digit CUH = 0.25	25,409 users	59,499	119,217	72,445	133,631	267,265	204,541
Alphanumeric 40 char. CUH = .30	7,260 users	17,000	34,062	20,698	38,180	76,362	58,442
Total system capacity	36,299 users	84,999	170,309	103,493	190,902	381,808	292,204

based on frame lengths (of 1,875 msec) within the POCSAG event lengths (no insertion within the batches) or within the ERMES sequences lengths, the encoder delay will fall within the already unused time (as a warmup time). As long as the encoder places pages in the expected frames, the order of the Flex frames does not matter.

Mixed format using same page types. By way of example, consider a system using POCSAG and Flex with the following properties:

- POCSAG 512.
- Warmup period time (programmable) = 100msec to 400msec when needed.
- Number of POCSAG users = 100,000.
- Number of Flex users = 10,000 (10% of the POCSAG users).
- Flex collapse value = 1 (for a period of two frames per minute, the Flex pager will look for a page).
- CUH = 0.15 for tone-only.
- CUH = 0.25 for 10-digit numeric.
- CUH = 0.30 for 40-character alphanumeric.

Assuming only one page type is used at a scenario, find the system utilization factor, the lost time percentage and the system capacity for each scenario for each page type. (See Tables 12, 13 and 14 on page 78.)

The formulas for mixed page formats (same page types) used in deriving values in the tables are as follows:

Number of batches or frames/min. is determined from the collapse value look-up-table (Table 12).

Number of POCSAG preambles/min. = ceiling(number of maximum batches per minute÷30), the number of batches/frame preceded with one preamble.

POCSAG pages time/min. = number of batches per minute × batch time (1.0625 at 512bps) + number preambles × preamble time (1.125).

Flex pages time/min. = number of frames per min. × frame time (1.875sec).

ERMES pages time/min. = number of batches per min. × 0.75sec.

Unused time percentage = 100 × [(60 − [POCSAG pages

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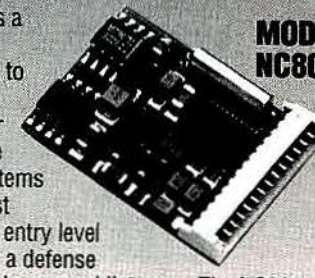

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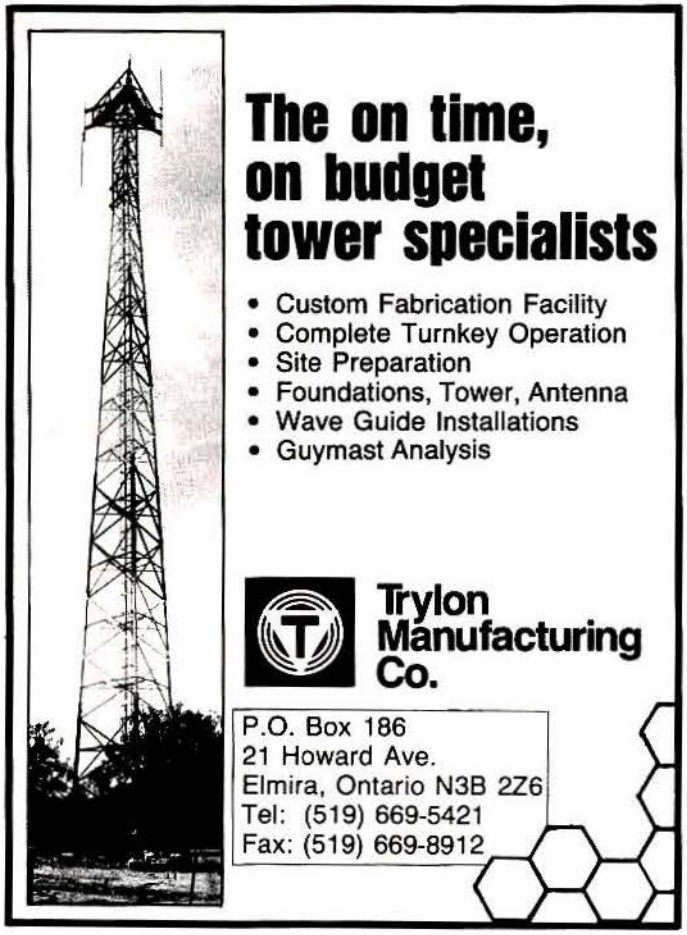

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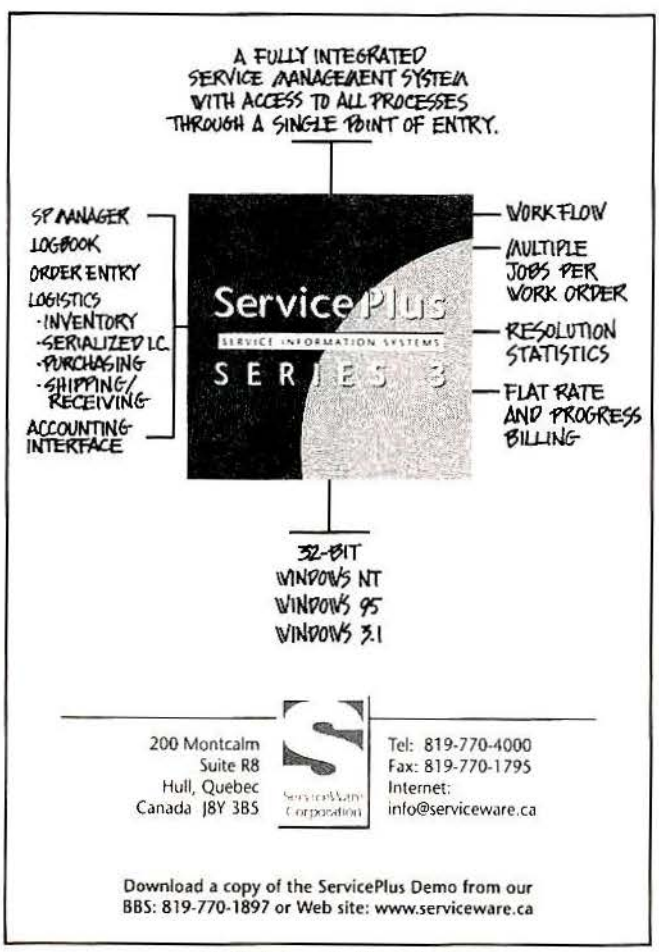

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Table 12—Look-up collapse value table.

Collapse value	Min. Flex frames/ minute	POCSAG num. of batches/minute			ERMES batches/ minute	GSC
		POCSAG 512	POCSAG 1200	POCSAG 2400	ERMES	GSC time slots
0	1	51	122	247	77	256
1	2	50	118	247	75	248
2	4	46	109	239	70	230
3	8	39	94	191	60	192
4	16	26	63	127	40	128

Table 13—General parameters for mixed-format (same page type) system.

Mixed page formats	POCSAG 512	Flex 1600
Number of offered users	100,000	10,000
Collapse value	NA	1
Max. batches or frames/min.	50	2
Number of preambles/min.	2	NA
Pages time/minute in sec.	55.375	3.75
Unused time/minute in sec.	0.875	NA
Percent of unused time	1.46	NA
Warmup time	0	

Table 14—Specific parameters for mixed format (same page type) system.

	Tone	Numeric	Alphanumeric
Call user hour CUH	0.15	0.25	0.3
Number of POCSAG traffic batches	937.5	5,000	30,000
Number of Flex traffic frames	34.88	119.05	600.00
Air time for Flex traffic in minutes	18	60	300.00
Max. POCSAG mixed batches in the Flex time	900	3,000	15,000
Overflow POCSAG time in minutes	0.69	36.67	275.00
Total air time in minutes/hour	18.69	96.67	575.00
System utilization	31.15	161.11	958.33
System capacity POCSAG	321,070	62,069	10,435
System capacity of Flex	32,107	6,207	1,043

time + Flex pages time]) ÷ 60].

Warm-up time/minute = 100 msec if the unused time is less than 100 msec.

Number of traffic batches or frames = (number of users × CUH) ÷ (number of pages per batch or frame).

Air time for Flex traffic in minutes = (number of traffic frames/minimum Frames per minute) according to the collapse value table.

Maximum number of POCSAG mixed batches = ceiling of Flex airtime minutes × maximum POCSAG batches per minute (derived from collapse value look-up table).

Overflow POCSAG time in minutes = [(traffic batches − maximum batches)÷30] × (33÷60), assuming 30 batches per event (of 33sec each event).

Total airtime in minutes = ceiling(Flex traffic needed time + overflow POCSAG time + warmup time.)

System utilization = (total air time in minutes ÷ 60) × 100.

System capacity = (100 × number of offered users per system utilization percentage).

The same principles apply for mixing ERMES and POCSAG formats.

The technology does not migrate in a short time. The system designer has to help to present a business case that shows that the current system serving the current formats is not going to be thrown away or replaced on a cutover date and time. He also has to show how many users will be served by both the new format and the old format. Any format used might serve any page type or mixed page types.

Computer analysis of intermod requires a pragmatic approach

A prescription for an effective computer program to calculate intermod includes practical and user-friendly techniques for entering and analyzing data.

By H.V. Church, P.E.

Some good programs for calculating intermodulation interference (intermod) are available, and most people with technical responsibilty for communications sites keep at least one program available on their computer. Unfortunately, many programs seem to be "user-antagonistic."

Some programs in DOS do not permit making a correction to a frequency that was entered incorrectly; you have to start all over again. Many perform endless calculations of frequency combinations and multiples that are entirely unlikely to produce intermod at any measurable level. Most programs fail to permit the user to tag the frequencies to make it possible to identify the licensee. Even so, any computer program beats the old days of performing the whole study by hand calculator or even by slide rule. Remember slide rules? I still have one. It props up the laptop computer on my desk!

Most programs ignore the fact that a station with several frequencies can only transmit or receive on one frequency at a time. These studies show combinations of two or more such frequencies transmitting at the same time and generating intermod products, which obviously cannot happen. This causes a lot of computer output that must be hand-checked and discarded.

Some programs calculate 5th-, 7th- or even higher-order intermodulation products. Experience shows that these higher-order products rarely cause problems, except with antennas that have little isolation or with old equipment or high power levels. The choice of using the higher-order combinations should be left to the program user.

It would be difficult to include all of the operating characteristics of a shared site, such as power output, effective radiated power (ERP), radio model names and numbers, types of filtering and isolation figures between antennas.

The proximity of intermod product frequencies to the receiver frequency is given in some studies as 0.010MHz, 0.025MHz or 0.050MHz. Other, larger values are used for FM and TV broadcast frequencies. Modulation levels may vary between narrowband FM and FM broadcast, as well as some of the more exotic forms of modulation, and these modulation levels should be part of the study.

Some services such as public safety two-way radio, specialized mobile radio (SMR), community repeaters and paging often are in heavy use during the working week. Others, such as rural fire departments, fish and game departments, forestry and agricultural services are used lightly, as well as seasonally. The difference in operating patterns implies that, although intermod interference *can* occur between some systems, there is not necessarily a statistically significant likelihood that it *will* occur.

An intermod analysis should realistically weigh the frequency and severity of radio interference against actual harm to the public welfare. For example, frequent occurances of intermod (called "hits") that affect a state police receiver would be considered unacceptable, yet occasional background noise on the radio system used by a towing service might cause less concern.

In any study, each frequency should be tagged with a short identifier to make it possible to recognize the user. There should be a summary showing the interfering transmitter combinations and the receiver being affected, including the frequency separation between the receiver and the intermod product. If some information on system-use cycles, ERP and antenna isolation were to be included in the study, the summary might include estimates on the probability that interference would occur. I have a site with a 1W broadcast translator and a 1kW broadcast transmitter that use antennas on the same tower. Power differences of that sort should be considered in any intermod study.

For the benefit of someone entering data to run an intermod study, it is important to be able to correct an incorrectly entered information, or to save the work in progress and exit the program (without invoking DOS scriptures) to come back to it later. A busy site may contain dozens, if not hundreds, of frequencies, and data entry takes a lot of time.

A program should be capable of examining the effects of all transmitters on a single receiver.

Above all it should be "user-friendly," and easy to store, so later studies can be done without re-entering masses of data.

Ideally, the study results should be evaluated by someone with a knowledge of the site and its individual systems, someone who knows whether circulators, isolators and combiners are in use, and who knows the general level of "housekeeping" and adherence to site rules. This individual must be able to make recommendations for any filtering or technical changes that may be needed. The summary or final report of the study must be brief and readily understandable because these documents sometimes are used, for better or worse, by non-technical people.

Church owns community repeaters, owns and manages radio communications sites and offers system design consulting service. He lives in Lebanon, New Hampshire.

Old man river ... he don't know nothin'

By Robert H. Schwaninger Jr.

For all you folks who suffered through the droughts that burned up West Texas, here's a story about the flipper side of the coin. Out here in the Northeast, it's been wet. We haven't had this much rain since some guy named Noah decided to try his hand at animal husbandry.

If you recall, this past winter, the Northeast was getting piles of snow, which is just rain with a better PR man. Anyway, the ground was already plenty soggy before the late spring rains started to fall and fall. This moisture fest caused flash flooding, slow flooding and general run-of-the-mill flooding, which is what happened when the creek near the FCC's Licensing Division in Gettysburg, PA, decided that enough was enough.

Schwaninger, *MRT*'s regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

You see, the creek washed over its banks, over the parking lot and down into the basement, aided by the circumstance of a basement door giving way under the water pressure. So, a few gazillion gallons of water poured into the FCC's basement where records are kept. Although the entire effect of the flood's devastation is unknown, the situation is made worse by the fact that the basement's storage included records that were slated to be shipped to the federal government's archives in Suitland, MD (a notoriously dry location), but that shipment was delayed.

So, what got wet? Among the records damaged are all the land mobile applications since Sept. 28, 1992; all common carrier microwave applications since March, 1992; all Marine applications since 1985; and many pending applications for both private and microwave licenses. What does it mean? The effect is difficult to judge, in both practical and legal terms.

In practical terms, the effect is problematic for the 800MHz grants. As the public has had an opportunity to study the FCC's computerized grant of many SMR applications, it has become apparent that many were granted in error, and the errors are never more evident as when you've got the applications in your hand. A lot of sloppy preparation work remarkably led to lot of grants that relied on improper short-spacing and other deficiencies.

Fortunately, most of the deficiencies can be detected using the FCC's computer records, but not always. So, the question remains, can a person challenge a grant of a license if he can't produce a copy of the defective application? Can the FCC demand that the applicant show a copy of the filed application if the application is challenged? There is no obvious legal obligation to maintain such records, so the licensee may figure the FCC's all wet for asking. I expect these cases will need to be decided one case at a time.

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applications for microwave licenses that have not yet been granted. It isn't clear how much of the data contained on the applications was used to create computer records, upon which the FCC could rely in eventually granting (or denying) the applications. If new applications have to be filed, who pays the cost of preparation? After all, most applicants do not see themselves as the commission's insurance carrier, and the cost of microwave engineering ain't cheap.

By the way, if you think that the employees at the FCC's Gettysburg office are ready to put in the overtime or take up a collection to save the lost records, think again. Morale at the licensing division might be dipping lower than a lead application in the flood. Rumor has it that the bureau's bean counters are contemplating laying off over half the staff at Gettysburg. It seems that Washington thinks that the Gettysburg staff is becoming outmoded by electronic filing. So while the records are "down-streaming," the office is "down-sizing."

Rumor has it that the bureau's bean counters are contemplating laying off over half the staff at Gettysburg. It seems that Washington thinks that the Gettysburg staff is becoming outmoded by electronic filing. So while the records are "down-streaming," the office is "down-sizing."

This attitude is consistent with the many problems that proponents of private radio have had with FCC Washington (not FCC Gettysburg) over the last few years. By the decisions, both internal and published, it's apparent that the policy makers don't understand or appreciate the role of private radio. Too many of the policy gurus think private radio is an outmoded service, like a human application processor.

What the policy wonks can't understand is why Joe's Towing Service would rather put up its own base station, rather than simply take cellular or ESMR or PCS service. So, to help these confused bureaucrats understand, let's all say it together—ready? MONEY! You see, Ms. Wireless Wonk, Joe has no desire to have automatic hand-off, interconnection, mobile data, enhanced global positioning satellite service, intelligent vehicles with smart cards or any form of TDMA, CDMA, spread spectrum, interactive, programmable, optical, video or single sideband. He just wants the drivers to hear the dispatcher within a few miles of his garage. Got it, now? Joe just wants to communicate—simply and cheaply. The last time I checked the records that didn't float away, there were about three million Joes out there with private radio licenses.

Now, I might be old-fashioned and ready for the bone yard, but I'm a lot like Joe. I don't require a lot of computerized glitz. When I file an application with the FCC, I expect that somewhere along the line, a human will look at it. They'll see if I got mustard on it, because I filled it out during lunch. Some guy will wonder if that's my signature or if someone inked an eel and set it on the page. Most important, I'll expect a human being to notice if my competitor's application is improperly prepared and should be chucked out the door. That's what I've come to expect, and I like it.

A computerized application bouncer just isn't the same. No computer could write the return notices that I've gotten over the years. Some are snippy. Some appear filled with hope. Some notices make you feel entirely stupid and direct you to do those things that you've done a million times before, but you forgot this once. All of them obviously came from a human, even if all they did was check a box marked, "Please resubmit employing waterproof ink," signed on behalf of Commodore Fishel.

Maybe a part of my ire about this downsizing stuff comes from being a former teamster. Local 688 wouldn't have taken this stuff. A strike would have been called, and we would have been sitting out in front of the Licensing Division with the 50-gallon drum fires burning and our "Unfair" signs raised. I wonder if the FCC staff at Gettysburg will do the same. After all, Gettysburg has a lot of experience with pickets.

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Champion offers 450MHz trunked communications in two formats

For two-way radio users searching for alternatives to cost-effectively enhance their dispatch capabilities, 450MHz trunked service may be the answer they have been looking for, according to representatives of Champion Communications Services, Houston. Champion is one of the first service providers in the United States to offer 450MHz trunked systems and provides 450MHz trunked service in nine states.

Champion first became involved in the community repeater business in 1994, following its purchase of about 1,500 community repeaters from Motorola in 22 states. The addition of 450MHz trunking was both a natural extension of the company's list of user services and part of its long-range business plan, company representatives say.

"If regulatory trends continue, there will be little, if any, new spectrum for land mobile radio users," said David Terman, Champion president. "The FCC also is encouraging users to consider shared systems. Thanks to the spectrum we already control, we can offer users the services they need, while addressing the FCC's objective of greater spectrum efficiency."

Champion offers trunking services in two formats—ETrunk developed by ETrunk Systems, Yorktown Heights, NY, and LTR from Kenwood Communications, Long Beach, CA. ETrunk systems are available in Arizona, Arkansas, California, Louisiana, Nebraska, New Mexico and Texas. Champion operates LTR-based systems in California, Illinois, Texas and is evaluating other markets. The company also is testing a SmarTrunk II UHF trunked radio system in Chicago and Houston using Motorola's Radius radios.

Modular Communications consoles are picked for forestry application

Modular Communication Systems, North Hollywood, CA, is supplying its Ultra-Com PRO microprocessor-based communications control system for the Boise, ID, interagency coordination center, covering emergency communications for the 2.6-million-acre Boise National Forest. Composed of seven dispatch positions, the system controls a minimum of 50 radio channels via one-button touchscreen select, covering 18 tone-selected repeaters. The consoles incorporate panel-mounted telephone key sets at each position. The Ultra-Com PRO features Screenmaker and Customizer programs, enabling the user to design screens and operating limits for specific systems and procedures.

Illinois Superconductor receives order for cellular filter systems

Illinois Superconductor, Mount Prospect, IL, has received an order from a U.S. cellular operator to purchase its SpectrumMaster filter systems. The order for 12 filters will outfit two cell sites in a metropolitan market using both analog and digital transmission protocols. Terms of the transaction, as well as the purchaser, were not disclosed.

Ora E. Smith, president of Illinois Superconductor, said the filters will be used in cells that carry a large number of calls. He said he believes that there will be dramatic improvements in network quality and capacity.

Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	−20	Bipolar	$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	−20	Bipolar	$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	$119.95
Inline (rf switched)						
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	−20	Bipolar	$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	−20	Bipolar	$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	$139.95

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Satellite technology reduces cost of high-speed data delivery

SpaceCom Systems, Tulsa, OK, is planning to offer HyperCubed, its newest satellite technology for point-to-multipoint distribution of high-speed data, in October. The technology, which uses the Galaxy IV satellite, will reduce the transmission costs of high-speed data channels via satellite.

The HyperCubed service will feature an eight-channel satellite receiver with extensive logging diagnostics and reporting capabilities. This "smart" receiver also enables customers to receive as many as eight satellite data channels simultaneously and will offer one of the industry's lowest-per-channel delivery costs for multichannel receivers.

The receivers allow the user to customize alarm settings; to access extensive logging records; to remotely upgrade software and to perform group addressing; and to monitor power, internal temperature, LNB current and signal quality.

SpaceCom will also offer its HyperCubed customers redundant transmission schemes and disaster avoidance by providing geographically diverse uplinking facilities and an in-orbit spare satellite (SBS-6). The new service augments SpaceCom's FM Cubed technology, which was introduced in 1991, and which has since been used by many of the nation's largest paging companies.

Al Stem, vice president and general manager of SpaceCom Systems, said that although HyperCubed was developed for the PCS and wireless industries, the technology has many applications beyond the PCS industry.

"This technology will offer addressable multichannel receivers at an unprecedented cost-per-channel, making it ideal for all types of information providers whose communications networks require group addressibility, large numbers of channels and many different data rates," Stem said.

Paging Partners network posts more than 1,000% revenue growth

Paging Partners, Freehold, NJ, was honored as the state's eighth fastest-growing technology company at *The New Jersey Technology Fast 50 Awards*, held at Newark's Gateway Hilton. From 1991–1995, Paging Partners posted revenue growth of 1,138%. The company provides alphanumeric paging and other one-way wireless messaging services to a network of more than 1,000 resellers along the I-95 corridor, with continuous coverage from southern New Hampshire to northern Virginia.

Lenbrook to market Cimarron GPS/AVL and ANI products in Canada

Cimarron Technologies, Escondido, CA, and Lenbrook Industries, Pickering, Ontario, Canada, have signed an agreement under which Lenbrook will have exclusive rights to market Cimarron's GPS/AVL and ANI product lines in Canada. Lenbrook, a value-added provider of wireless products and systems, will provide marketing, sales and technical services for Cimarron's Skymark VehicleTracker products. The company will provide similar services for Cimarron's automatic number identification products. Included are GE-STAR-compatible base dispatch display units, subminiature encoders, encoder-decoders with PTT ANI, EM, man-down and two-way remote control features.

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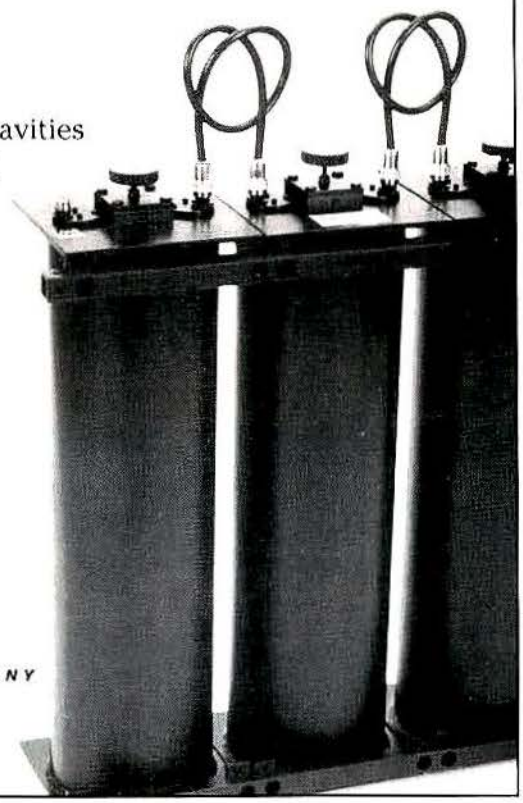

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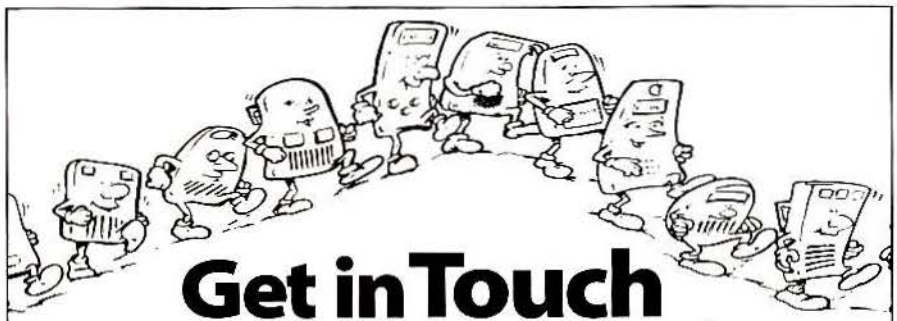

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News

WPCS endorses Uniden's enhanced SMR protocol

Wireless Professional Communications Services (WPCS) has endorsed ESAS, Fort Worth, TX-based Uniden America's enhanced SMR protocol as its wireless network technology. WPCS is a national consortium of independent operators that are working together to remain competitive in the wireless marketplace. WPCS is also working with other SMR groups in creating a new wireless network standard.

ESAS will be used throughout those systems operated by WPCS members. Although these systems are extensively based in the Northwest, coverage will extend throughout the upper section of the country, from Washington and Oregon to Michigan and down to Mississippi.

ESAS is Uniden's extended protocol designed primarily for the worldwide analog SMR marketplace. It provides an enhanced feature set including unique identification numbers, individual mobile calling and control, as well as networking and tracking capability. ESAS provides additional subscriber features and validations, including additional ID codes, deadbeat disable function and mobile-to-mobile selective calling.

Cellular carrier, vendor join forces to assist Bethlehem, PA police

Bell Atlantic NYNEX Mobile, Bedminster, NJ; Cerulean Technology, Marlborough, MA; and the Bethlehem, PA, police department have equipped several police cruisers with laptops using a new wireless data technology that allows fast access to information from motor vehicle and criminal information databases. Officers can make an inquiry and can obtain information in seconds without having to contact the central dispatcher. Cerulean's PacketCluster Patrol software works with Bell Atlantic NYNEX Mobile's cellular digital packet data (CDPD) network known as AirBridge. The software provides the police officers access to federal, state and local motor vehicle and criminal records.

Through an agreement with the Pennsylvania state police, the officers will also be able to access the National Crime Information Center and the Commonwealth Law Enforcement Assistance Network. These two data warehouses provide information on wanted and missing individuals and stolen vehicles.

The officers will be able to "silently" communicate car-to-car as well as car-to-dispatch through electronic mail messages. Communication between the AirBridge network and the PacketCluster Patrol system is secure because both systems use encryption.

Simmonds expects to net $26 million in divestiture

Simmonds Capital Limited (SCL), Willowdale, Ontario, Canada, expects the proceeds of the sale of interests in the radio communications equipment distribution business to reach $26 million ($35 million Canadian), including cash and publicly traded securities. Under current plans, SCL will sell the U.S. land mobile radio distribution business of Kansas City, MO-based Midland International (an SCL subsidiary) to Intek Diversified, a Torrance, CA, company controlled by SCL. In turn, a subsidiary of Securicor Group, Surrey, UK, will be acquired by Intek in exchange for Intek stock—placing Securicor in control of Intek and, thus, Midland International. At closing, SCL will receive pre-tax proceeds of about $26 million and will retain an 11% interest in Intek.

In 1995, SCL's radio communications equipment distribution business had sales of $35 million and incurred a loss of $7 million. SCL expects to realize a profit from the transactions with Intek and Securicor.

Motorola releases paging protocol site on World Wide Web

Motorola's Messaging Systems Products Group, in cooperation with the Personal Communications Industry Association, has made the Telocator Data Paging (TDP) suite of protocols available free of charge to wireless application developers on the World Wide Web. The TDP protocol suite allows wireless product users to send files, pictures and two-way messages over one- and two-way paging networks.

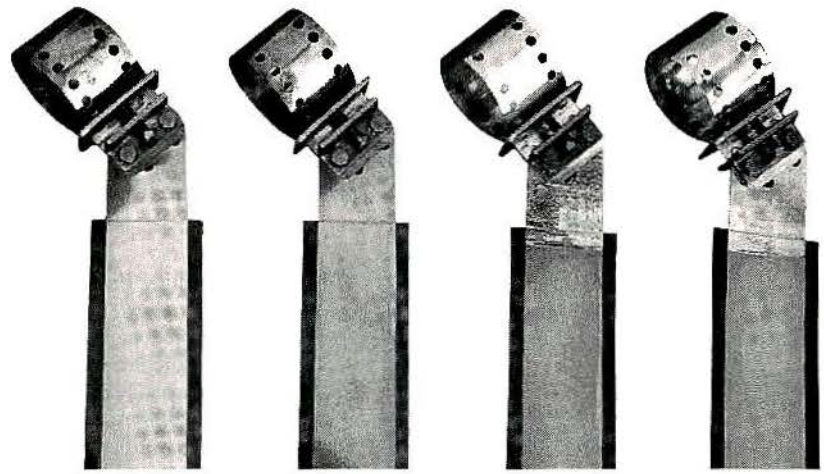
The protocol suite, in hypertext, Adobe, Acrobat and Adobe PostScript formats, can be accessed through PCIA's web site at http://www.pcia.com.

The protocol allows wireless application and product developers to harness the increased capacity and faster speeds of advanced messaging technologies such as Motorola's Flex family of protocols.

Geotek selects Coherent echo cancellation equipment

Coherent Communications, Leesburg, VA, has signed an agreement with Geotek Communications, Montvale, NJ, to supply echo cancellation and voice-quality equipment for the Geotek FHMA network. Ronald Vicari, senior director of network engineering for Geotek, said that the contract was awarded on the basis of performance, serviceability and operational flexibility.

New Unique Cable Grounding Kit Series



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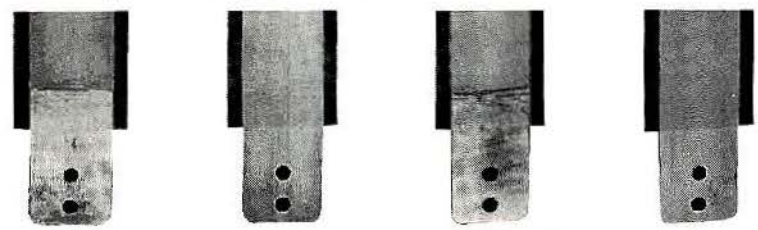

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Circle (79) on Fast Fact Card

News

PageNet tests paging service where person sending message pays

PageNet, Dallas, is test-marketing Value Page, a service that allows pager owners to avoid monthly service charges. With ValuePage, the person sending a page, rather than the pager user, pays for service. PageNet is testing the service in Chicago, Detroit and Indianapolis. Value Page is made possible by an agreement between PageNet and Ameritech. Ameritech logs all calls to Value Page pagers from its phones during the month and bills its customers through their regular monthly invoices. When an individual places a call to the subscriber's pager number, a voice message alerts the caller that he or she will be charged a small fee—generally 35 cents or less—on the callers's telephone bill. Ameritech shares the revenue with PageNet, allowing PageNet to offer pager service at no cost to pager users.

Metrocall acquires Parkway Paging

Metrocall, Alexandria, VA, has completed its acquisition of Parkway Paging, Plano, TX. The purchase price was about $28 million in cash. Parkway Paging has about 140,000 subscribers throughout Texas. Metrocall continues to pursue aggressive acquisitions to build its subscribers base. Over the next several quarters, Metrocall plans to close acquisitions putting it at about 2.2 million subscribers on a pro forma basis.

PCSD contracts with Glenayre, Motorola for infrastructure equipment

Glenayre Technologies, Charlotte, NC, has signed a $75 million contract to provide narrowband PCS equipment for PCS Development's (PCSD) nationwide network. PCSD's system uses Motorola's InFlexion protocol and will provide voice message paging service using Glenayre's GL3000 wireless messaging switches, GL3100 RF directors, GL-C9000 controllers, GL-T9000 linear transmitters and GL-R9000 receivers.

PCSD, Greenville, SC, has signed an initial contract of nearly $50 with Motorola's Advanced Messaging Group, Fort Worth, TX, for InFlexion-based infrastructure equipment and Tenor advanced voice messaging units. Beta testing of PCSD's voice messaging network is scheduled to begin in the third quarter of 1996.

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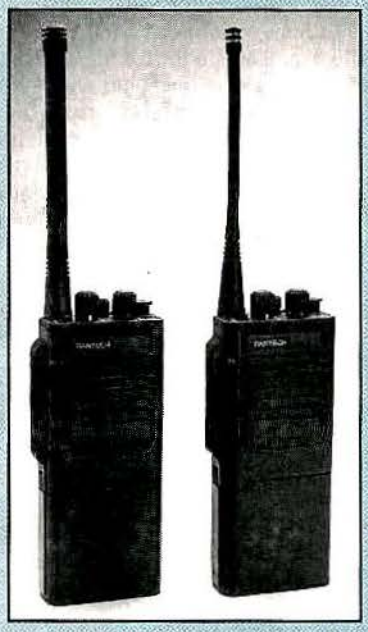
Readers' choice

Of all the new products and services in the February 1996 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

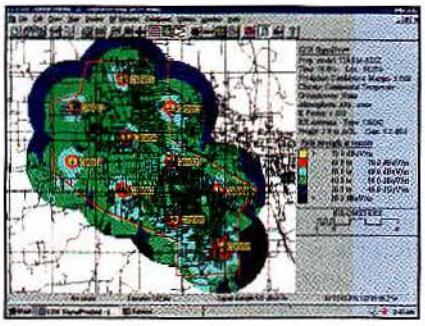
Portable radio sports diecast frame, rubber gasketing



The PS-series portable radios from **Pantech America** allow the user to switch from 5W to 2W of RF power in both VHF and UHF models. An "I-beam" alloy diecast frame separates the radio's RF section from its control section. Rubber gasketing incorporated into all channeling on the frame housing provides environmental integrity equated to MIL-STD-810. Each radio has as many as 16 channels with built-in CTCSS and DCS, as well as selective channel scan, priority scan and all-scan. Standard features include battery-save, busy-channel lockout and delayed TX.

Circle (500) on Fast Fact Card

Design software combines access to databases, mapping, analysis



EDX SignalPro from **EDX Engineering** is design software providing planning tools for cellular, PCS and other wireless communications systems. The software, based on EDX's original Signal for DOS program, is designed to run under Microsoft Windows 95/NT. The basic program includes mapping capabilities, multisite coverage and interference analysis, multiple point-to-point analysis, and propagation models. Access to terrain, groundcover and demographic databases is provided. Bit-error rates can be calculated and mapped, and root-mean-square delay spread and other time-dispersion studies are supported, including dynamic channel time and frequency signature analysis.

Circle (401) on Fast Fact Card

Universal connectors allow easy Type N to 7/16 DIN conversion

Universal-fit connectors for $1^5/_8$" cables from **Tessco** feature interchangeable heads, allowing easy conversion from a Type N to a 7/16 DIN and easy replacement of a damaged contact. To install, screw the center pin into the center conductor of the cable and then tighten with an open-end wrench. The connector's self-flaring design provides proper contact with the outer conductor, while lessening cable preparation time. Spring fingers, which grip the outer conductor, rotate within the body, eliminating bending or breaking during installation. An extra-thick gasket provides secure weatherproofing. Proper seating and compression is ensured by the unit's double-back-nut, which is tightened only at the last step of installation. The connectors are backed by a five-year warranty.

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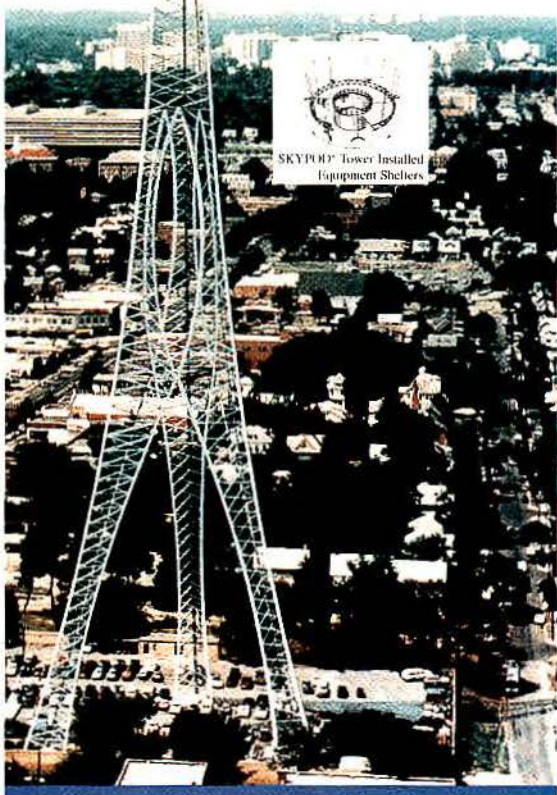

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New products

Panel-mount male, female 7/16 receptacles replace Type N connectors

TRU-7666/7686 panel-mount receptacles are 7/16 female and male direct replacements for Type N connectors that eliminate the need for panel modification. Designed to ensure low intermodulation, the receptacles from **Tru-Connector** provide 50Ω impedance and are rated for 2,700Vrms. The units have either gold or silver center conductors, BeCu contacts, Teflon insulators and either a nickel- or silver-plated brass body.

Circle (403) on Fast Fact Card

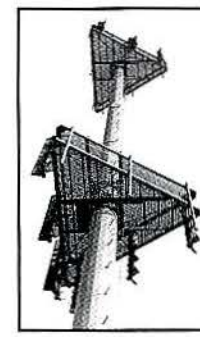
Digital repeater extends range of digital POCSAG paging channel

Zetron's model 55D digital repeater for POCSAG radio paging extends the range of a digital channel. The repeater features simplex store and forward of POCSAG using the main paging channel. It has a large buffered storage capacity of 17 minutes at 512 baud and provides error correction.

The rack-mount unit samples paging information directly from a receiver's discriminator circuitry. When POCSAG paging data is detected and the baud rate is determined, the unit begins to "record" the digital paging information into a large RAM buffer. When the original transmission is complete, the repeater closes its PTT relay and retransmits the buffered paging data.

Circle (404) on Fast Fact Card

Application-specific monopoles provide high-strength support



Sabre Communications' monopole line includes poles designed specifically for ESMR, PCS, cellular and microwave applications. The monopoles, which extend to as high as 180 feet, are constructed in tapered sections for efficient on-site assembly and minimal visual distraction. Options include service platforms, antenna support brackets, step-bolts, conduit hubs, reinforced hand-holes and a pole cap. The shafts are high-strength steel with a minimum yield strength of 50,000psi and a tensile strength of 70,000psi. Available finishes include self-weathering steel, hot-dip galvanization, primer coating for field painting or a factory-applied, baked-on finish coat.

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Circle (82) on Fast Fact Card

Multipurpose broadband antenna encompasses 800MHz to 3GHz

The Max System Discone antenna from **Max System Antennas** fulfills special needs for covering frequencies between 800MHz and 3GHz. As a broadband antenna, the discone can be used in omnidirectional, unity gain applications such as wireless data and voice for cellular, PCS and wireless LANs.

Circle (406) on FAst Fact Card

Telephone interconnect features remote OTA automatic setup

The 4700VP telephone interconnect is the first in a new series of land mobile interconnect products from **Communications Electronics Specialists (CES).** The simplex and semi-duplex 4700VP can be installed into nearly every repeater/transceiver on the market. An automatic setup feature can be programmed OTA or locally. Features include 25 speed dial locations; VeraTec, CES' proprietary smart sampling protocol; 10-digit connect/disconnect code; pulse or tone; toll restriction with inclusion and exclusion numbers; lightning protection; built-in repeat audio path and last-number redial.

Circle (407) on Fast Fact Card

UHF hand-held delivers 4W output for business, public safety applications

E.F. Johnson's UHF model of its Avenger SE hand-held radio comes in eight- or 16-channel models for business, industrial or public safety applications. The 4W-output radio provides synthesized wideband operation. PC-programmable features include priority scan, scan channel lockout, receive-only channels and vox for 16-channel models. The radio meets MIL-STD-810 specifications for endurance and delivers eight hours of operation on a standard 1,100mAh battery.

Circle (408) on Fast Fact Card

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Circle (85) on Fast Fact Card

New products

Base station antenna system line includes coaxial cables, accessories

The **Decibel Products Division** of Allen Telecom Group has added a complete line of coaxial cables, connectors and accessories to its line of base station antenna systems. The TransTelecom product family includes foam, superflexible, air-dielectric and radiating, or leaky, cables. All cables include connectors, jumpers and associated accessories. All cables are tested to ensure VSWR performance, attenuation and signal propagation. Decibel's connectors also have four O-rings, instead of three, to prevent water migration.

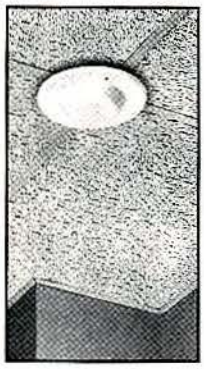
Circle (409) on Fast Fact Card

Compact synthesized hand-held provides 99-channel selection

The 99-channel MicroTalk from **Advanced Videotech** is housed in a die-cast aluminum frame. The MicroTalk is a 5W VHF, 4W UHF, synthesized two-way radio. The radio operates on a frequency range of 136MHz–174MHz VHF and 436MHz–470MHz UHF. The unit includes a Rubberflex antenna, 700mAh NiCd battery and 110Vac wall charger. A belt clip and wrist strap also come with the radio. A warranty of two years on both parts and labor is included.

Circle (410) on Fast Facts Card

Ceiling antenna improves in-building coverage for cellular systems



The Illuminator is a fiber-fed active indoor antenna system. It provides improved cellular coverage inside large, open buildings such as auditoriums, malls, convention centers, and office complexes. The Illuminator from **Andrew** is compact and easy to install. Its single-point source antenna allows remote feeds from as far as a mile away. Its direct RF-modulated fiber optics can be split between several antennas. The Illuminator is compatible with analog and digital modulation schemes. Troubleshooting is simple because of the built-in, self-supporting diagnostics. A loopback alarm system detects RF outages with external alarm contacts. The system also provides increased coverage area with 10mW remote RF output per channel. Its composite riser/plenum-rated cable combines copper for electrical power and optical fiber for signal.

Circle (411) on Fast Facts Card

Workstation combines vehicle communications into one system

The Enhanced Mobile Workstation from **Geotek** is an integrated mobile phone, dispatch radio and messaging system with a 5", 100-character display. Status indicators automatically note signal strength, new messages and active functions. Menu keys and dedicated keys access the screen-based options and communications systems. A serial port allows connection to in-vehicle peripherals, and a built-in speaker allows hands-free operation.

Circle (412) on Fast Fact Card

Foam dielectric coax cable sports tight bending radius for assemblies

ExtraFlexible foam dielectric coaxial cable from **Andrew** combines flexibility and high-quality electrical performance. The EFX2-50's deep annular corrugations ensure a moisture-proof transmission line, which is good for PCS and PCN, cellular and rural telephony applications. With a bending radius of 1.75", the cable also is suitable for inter-rack and intra-rack assemblies. At 894MHz, the EFX2-50 has an attenuation of 3.48dB/100 feet and an average power of 0.675kW. A full line of connector interfaces, including Type N and 7/16 DIN, are available. There are also many accessories to simplify installation.

Circle (413) on Fast Fact Card

International databases support terrain analysis modeling software

SoftWright has acquired international terrain databases for use with its Terrain Analysis Package (TAP) software. More than 90 countries are available in digital elevation models. These models can be integrated into TAP to evaluate the suitability of radio transmitting and receiving sites.

Circle (414) on Fast Fact Card

Test receiver requires less than a second to sweep 30MHz to 2GHz

The Xplorer test receiver is a multipurpose nearfield communications test and surveillance sweeper that sweeps from 30MHz to 2GHz in less than one second. It automatically stops on any active frequency, demodulates the audio and displays the frequency of the transmitted signal. **Optoelectronics**' Xplorer decodes and displays sub-audible signaling tones, including DCS, CTCSS and DTMF. The unit displays FM deviation and relative signal strength and operates in VFO mode for manual tuning to a specific frequency. As many as 500 data records can be stored in memory, as well as 1,000 hits per frequency. The Xplorer also locks on to two-way FM transmissions as far as ¼ mile away. Features include CI-V-compliant serial data interface with both TTL and RS-232C levels, real time clock and calendar with battery back-up, frequency skip button and tape recorder pause control relay jack.

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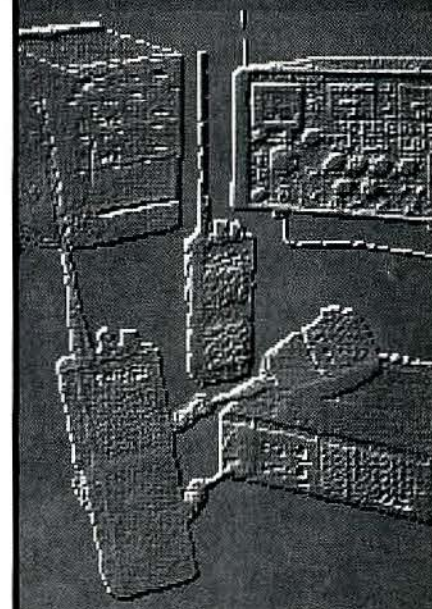

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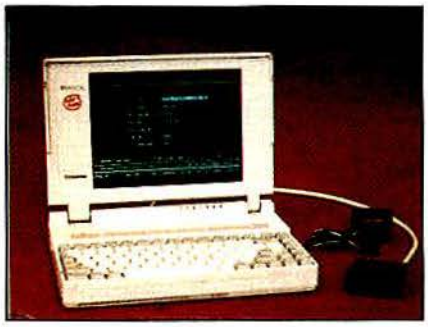
Circle (86) on Fast Fact Card

New products

Paging encoder with repeat mode supports tests for three protocols



The Paging Encoder from **Linktronic Systems** is a computer-based system for POCSAG, Golay and Flex pager testing. Features include capcode increment/decrement, one-key configuration change and preprogrammed canned messages with as many as 240 characters to maximize the throughput in pager testing. Also included are a repeat mode with automatic page data increment, an NEC test mode and optional OTA programming for Samsung pagers.

Circle (416) on Fast Fact Card

Portable test package comprises 20 instruments for cellular, PCS bands

The CyberTest lightweight, portable platform from **Motorola Communication Test Equipment** is a user-programmable dual-component wireless communications test system that features more than 20 instruments, including an analyzer for test and measurement functions and a PC for overall control and Windows-based graphical interface. It works in the cellular and PCS frequency bands. Dual plug-in Smart Modules allow the platform hardware to be customized so that multiple digital and analog wireless systems can be tested. Initial applications are for CDMA and analog infrastructure and analog subscriber testing. Software can be upgraded in the field.

Circle (417) on Fast Fact Card

Automatic cellular modem test system emulates end-to-end link

The GT-Cellular Lite automatic cellular modem test system from **Telecom Analysis Systems** can test cellular modems and other cellular data communications devices. The test system emulates an end-to-end, cellular-to-PSTN communications link and provides performance tests for cellular modems. Standard system components include TAS 6600 wireless communications analyzer, TAS 100 series telephone network emulator, TAS Gemini dual terminal emulator and TASKIT for Windows software.

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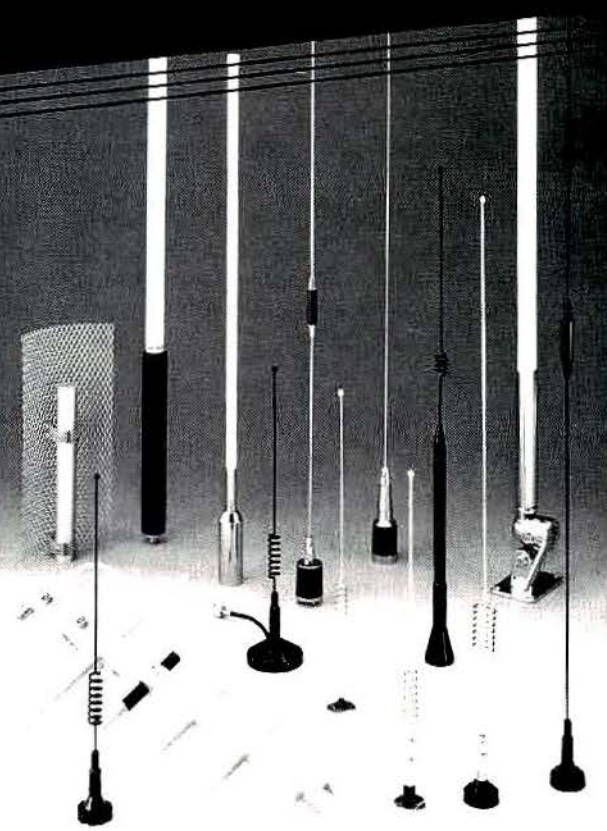


Circle (87) on Fast Fact Card

Desktop control consoles include programmable buttons, expandability

The Comtegra programmable desktop control console from **Motorola Land Mobile Products Sector** offers a choice of three models: one-station, one-station expandable and two-station. Comtegra includes programmable buttons for quick access to commonly used functions, paging, radio and telephone patching and multifrequency operations. Other features include communication with base stations using tone, DC or E&M remote control; compatibility with Motorola Stat-Alert two-way radios; Radio Service Software programming capability; and backlit LCD. These compact consoles are designed for use by federal, state and local law enforcement, police, fire and emergency medical services.

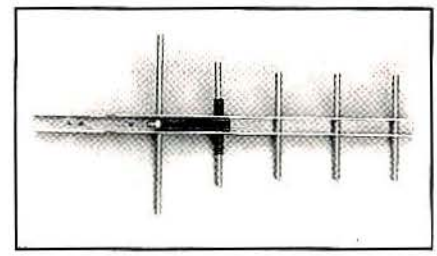
Circle (419) on Fast Fact Card

Channel architecture gets six channels from existing 25kHz channel

Unique Technologies International offers a development kit to manufacturers for DC/MA (Dynamic Channel Multi-Carrier Architecture) technology. DC/MA makes six independent channels inside an existing 25kHz channel. The six channels are divided into five voice channels also capable of carrying 9,600-baud data and one 2,400-baud channel for data only. The technology can be interfaced with most trunking systems, allowing a transition of one channel at a time. DC/MA mobiles and portables are dual-mode, operating on DC/MA channels or 25kHz FM channels, maintaining capability with existing equipment.

Circle (420) on Fast Fact Card

Point-to-point yagi antennas are designed for fixed-site applications



Yagi antennas for point-to-point signal transfer are available for specialized mobile radio (SMR), cellular and ISM bands. They come in 6dBd, 9dBd or 10dBd gain. The antennas consist of an aluminum channel with a series of solid elements. The elements are welded together for strength and proper electrical transfer, and they have a protective weather-resistant covering. The antennas from **Mobile Mark** terminate with a choice of either a TNC or N connector. Maximum mast diameter is two inches. All mounting hardware necessary to attach the antennas to a mast or pole is provided.

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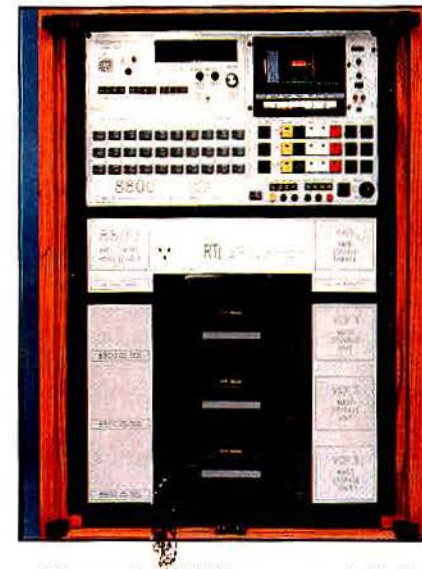
Circle (88) on Fast Fact Card

Trunking-compatible mobile data system has encryption, full graphics

The KDT-5000 Mobile Data System from ***King Communications U.S.A.*** offers an eight-line, full-graphics display allowing a complete 320-character message to be shown on the screen. Used with an optional keyboard, the unit can transmit full text messages from the vehicle as well. The unit is fully compatible with conventional and trunked radio systems and can be integrated into existing equipment. Data throughput rate is 6,000bps even on 12.5kHz systems. Data is fully encrypted to prevent interception.

Circle (422) on Fast Fact Card

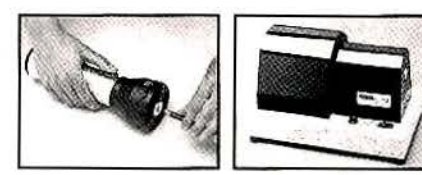
Non-voxed logger features cassette download recorder, speaker phone



The model 8800 non-voxed digital voice logging recorder from **Reproduction Technologies** works for 911, security and telemessaging center voice recording. Twenty-four-hour continuous recording is done on standard VHS video recorders. Built-in features include cassette download recorder; automatic search; speaker phone for on-site teleservice; and easy phone, radio or room microphone connections.

Circle (423) on Fast Fact Card

Stripping tools speed preparation of coax in field, at workbench



Two coaxial cable stripping tools from **Remarcable** are designed for field applications and bench-top use. The 800 series tool (left) is for light-duty assembly and field applications requiring portability. The 3-pound tool is powered by either a rechargeable NiCd battery pack or by an ac power supply. The battery pack provides power for about 200 strips per charge. The 1200 series bench-top production stripper handles a wide range of cable types and diameters from 0.030" (0.75mm) to 0.625" (16mm). Both tools strip coax and wire using all-metal, quick-change blade cassettes. Blade depth adjusts and a strip length stop ensure consistent results.

Circle (424) on Fast Facts Card

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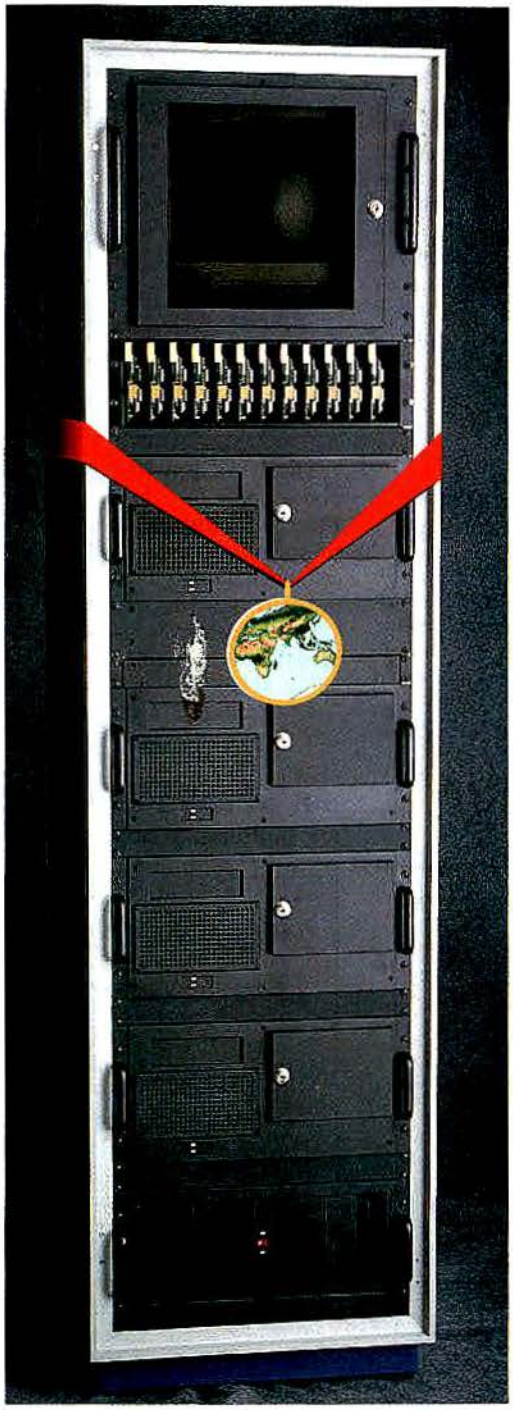

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New products

Land mobile antenna line provides stocking options for distributors

The Mosaic line of antennas from **Antenna Specialists Division** of Allen Telecom Group can be procured by dealers and distributors as complete assemblies or as individual components. The modular UHF and VHF antennas have separate, interchangeable base coils, springs, whips, and mounting and cabling components. Various mounting configurations are supported, including low-profile NMO-style roof mounts.

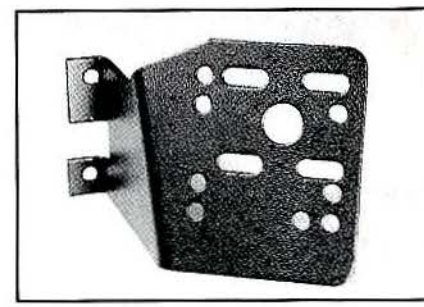
Circle (425) on Fast Fact Card

Controller allows paging systems to expand regionally, nationally

The TNPP-EX network controller from **Hark Systems** allows a paging system operator to extend regional or nationwide paging to customers. The 32-port unit offers an optional statistics computer so customer useage information can be collected for reseller billing, support of modem and data rates of 115.2kbps.

Circle (426) on Fast Fact Card

Mounting bracket designs match dashboards of specific vehicles



The Dash Pro line of cellular telephone mounting brackets from **SMC Electro-Mount** are custom-designed to fit specific vehicle models. The brackets attach quickly to the dashboard without any drilling, using instead the existing dash trim holes. More than 50 models are available, with new models being developed.

Circle (427) on Fast Fact Card

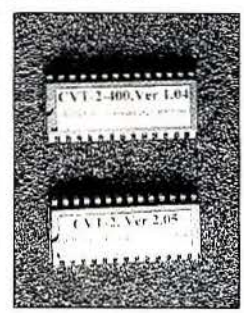
UHF transceiver offers 20-channels for building, security applications

The PROCOM MU520, a 20-channel UHF FM synthesized programmable transceiver, can be programmed to receive additional channel frequencies with the CPK-520 programming kit. A cloning cable for programming frequencies from one preprogrammed unit to another is also available. The unit from **Fanon Courier** operates on General Mobile Radio Service and Business Band Radio Service from 450MHz to 470MHz. This high-power miniature hand-held transceiver is suitable for use on construction sites and in and around buildings, as well as for security control. Its features include 20-channel selector, digital channel readout, power switch, channel lockout, volume control/power on-off switch, built-in tone coded and digital squelch controls, scan/priority and time out indicators. A weather-resistant, die-cast aluminum frame houses the transceiver. Complete with the high-impact case and belt clip, the PROCOM MU520 weighs only a pound.

Circle (428) on Fast Fact Card

EEPROMs Provide Trunking Conversion For Mobiles

IDA Corporation of Fargo, ND announces the availability of LTR trunking conversion EEPROMs for various Motorola and Motorola Radius mobile radios. The replacement EEPROMs are available for popular models in the 400MHz, 800 MHz and 900MHz bands. LTR conversion of Privacy Plus mobile phones is also being offered. An inexpensive programming kit is required to program the converted mobiles. Post-conversion features include group scan, TX time-out timer, trunked or conventional operation, CTCSS and CDCSS, block decode and automatic channel acquisition.



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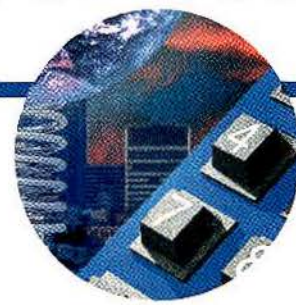

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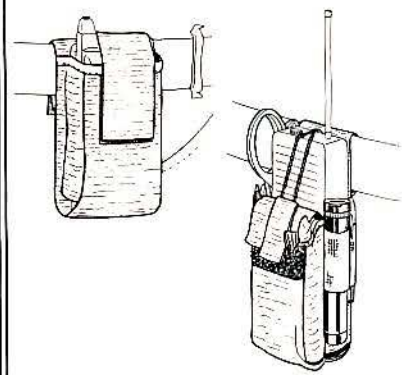

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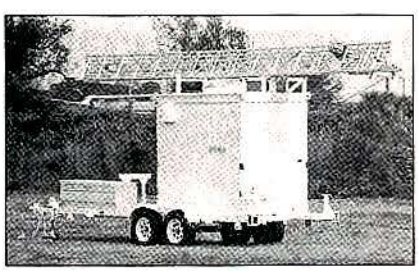

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Circle (96) on Fast Fact Card

New products

Windows-based software ties vehicles to office computer system

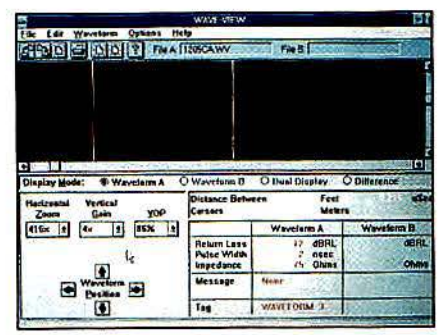
D&L Communications' Wireless for Windows allows mobile workers to interface with Microsoft's Windows-based office products. The software requires a PC-based computer system and an Ericsson EDACS wide-area radio system. Future releases will be designed to work with other radio systems. Initial functions involve transmitting electronic mail from a LAN base to vehicles. Additional releases will add database access, creating forms, scanning bar codes, visuals and Internet access.

Circle (429) on Fast Fact Card

Software allows waveform storage from time domain reflectometer tests

Wave-View for Windows software for the 1205C and 1205T time domain reflectometer/cable fault locators allows waveform storage for later manipulation. The software from **Riser-Bond Instruments** displays the TDR's function keys, allowing the user to increase the vertical gain, zoom in and out, adjust the cursors and change the VOP.

Circle (430) on Fast Fact Card



High-profile, glass-mount antenna cuts wind noise, secures tightly

The **Antenna Company** offers the K3 glass-mount antenna under the Maxim brand name. Each K3 is available in consumer-focused retail packaging. The antenna incorporates the Quiet-1 enclosed-coil mast. A straked design channels air movement around the mast to eliminate wind noise. The Thermo-flex plastic foot bonds securely to curved windshields. A tall mast clears the high roof lines of sport utility vehicles and trucks.

Circle (431) on Fast Fact Card

continued on page 127

Distribution

Future Electronics, Montreal, Quebec, enters into an agreement to distribute the full line of coaxial connector products from the RF Connector division of **RF Industries.**

For more information, call 800-233-1728

Hutton Communications increases its distribution facilities with the addition of a Camp Hill, PA, warehouse location jointly shared with **Andrew**. Hutton has been an Andrew distributor since 1986.

Hutton also adds to its product line with an authorization to distribute **PolyPhaser** lightning/EMP protection and grounding products through its six U.S. locations.

For more information, call 800-442-3811

Talley Communications increases its product distribution capabilities with the addition of a new warehouse in Hayward, CA, shared jointly with **Andrew**. Talley has been an Andrew distributor since 1986.

For more information, call 510-783-2111

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People

Jankowski

Huttenburg

Thornton

Kimball

Richard M. Jankowski departs Hammond Electronics, Orlando, FL, as general manager of value-added products to become president of LBA Technology, Greenville, NC.

Debra Buck Huttenburg, business unit manager for the broadcast and earth station antenna systems business at Andrew, Orland Park, IL, advances to vice president of antenna systems.

Changes at Wynd Communications, San Luis Obispo, CA:

Don Thornton departs Lockheed Martin IMS, Phoenix, as vice president of operations to become vice president of operations at Wynd Communications.

Bob Kimball leaves Stella Interactive, Carlsbad, CA, as vice president of sales and marketing to join Wynd Communications as vice president of marketing and technology.

Daniel R. Luis, general manager at Wynd Communications advances to vice president of business development.

Robert Vecsler, corporate counsel for Geotek, Montvale, NJ, advances to general counsel and secretary.

Bruce Hamlin exits Boatphone, Tortola, British Virgin Islands, as general manager to join The Intertek Group, Dedham, MA, in wireless product sales for the northern New England and eastern Massachusetts regions.

Robin T. Jacoby leaves Marconi Instruments, England, as senior applications manager and communications product line manager to join Boonton Electronics, Parsippany, NJ, as western regional sales manager.

Richard Nelson, vice president of marketing for PageMart, Dallas, becomes president of the company's wholly owned subsidiary, PageMart International.

Changes at RAM Mobile Data, Woodbridge, NJ:

Robert Hutton exits Inacom, Omaha, NE, as vice president of national integration services to join RAM Mobile Data as vice president of technical services.

Sheri Kosh Hutton departs Software AG of North America, Reston, VA, as director of international service operations to become director of product engineering for RAM Mobile Data.

Glenn Stephens, director of systems development for RAM Mobile Data advances to director of professional services.

Changes at Glenayre Technologies, Charlotte, NC:

Ramon D. Ardizzone, chief executive officer for Glenayre, Charlotte, NC, takes additional responsibilities as chairman.

Gary B. Smith, executive vice president of Glenayre and vice president of the Wireless Messaging Group moves up to president of Glenayre. He also joins the board of directors.

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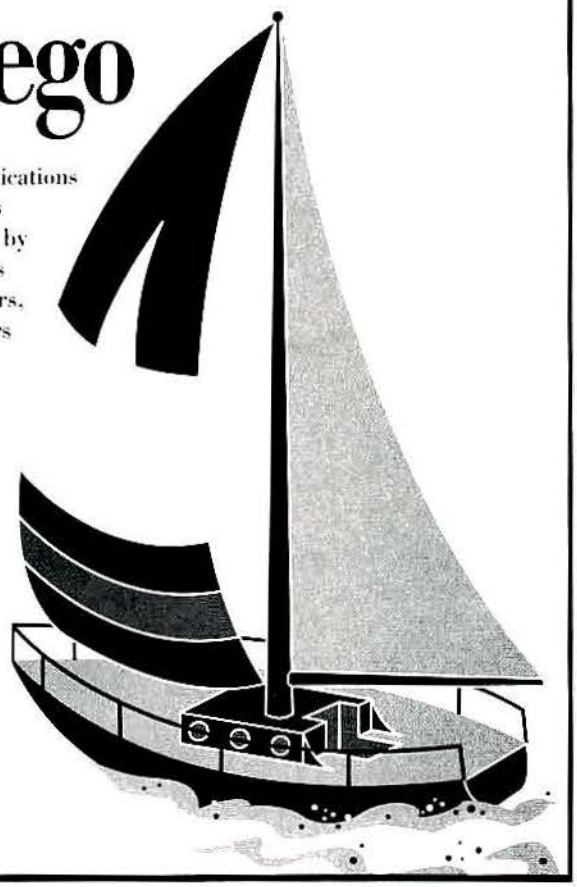

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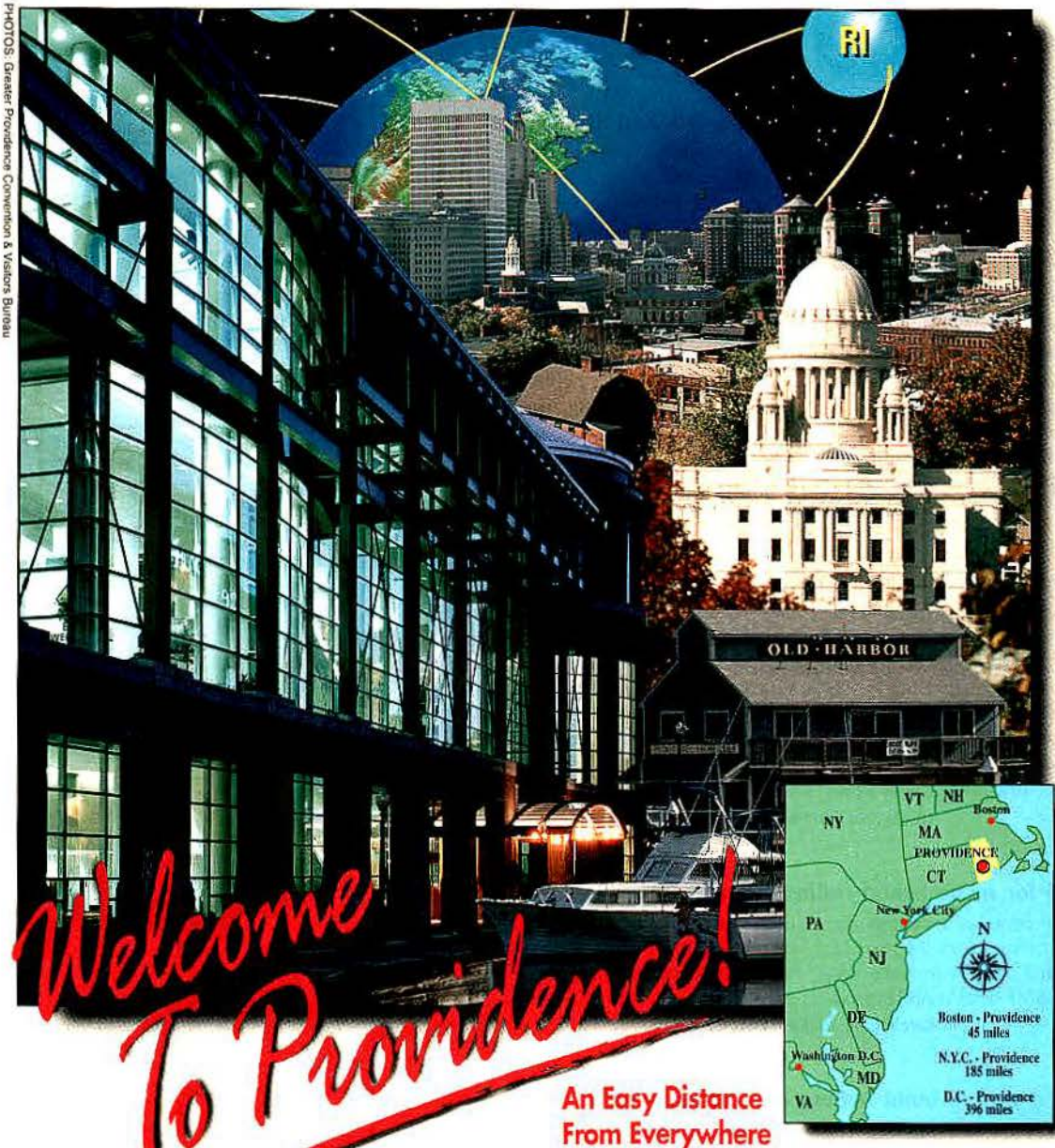
PHOTOS: Greater Providence Convention & Visitors Bureau



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Circle (98) on Fast Fact Card

Literature

Catalog features consumer electronic repair parts and accessories

The latest catalog from **MCM Electronics** contains more than 3,800 new items such as project accessories, semiconductors, connectors and test equipment. Prices have been permanently reduced on semiconductors, video heads and flybacks, and MCM has become an authorized distributor for Panasonic service parts. This free catalog is geared toward service technicians and electronic enthusiasts.

Circle (201) on Fast Fact Card

Catalog showcases two-way radio accessories

A 16-page catalog from **Dynatech Tactical Communications** features photos and data for two-way radio accessories including security kits, wireless earphones, transductors and microphones. The accessories fit most popular radios by Motorola, Ericsson, Kenwood, King, Maxon and Standard. The accessories feature overmolded connectors for maximum durability and reliability.

Circle (202) on Fast Fact Card

Catalog features an expanded line of coaxial connectors

The free, 12-page catalog from **Tru-Connector** contains an expanded line of standard 7/16 RF coaxial connectors that are available in straight, right-angle, in-series and between-series configurations. The European-type connectors are manufactured in the United States and fit most cables from 0.141" to 0.875". New products featured in the catalog include 7/16 panel receptacles with an N-connector footprint to facilitate system upgrades and save space, and a range of connector cable combinations. The catalog contains photographs, drawings, performance specifications, construction materials and complete ordering information.

Circle (203) on Fast Fact Card

Guide is source for name brand radios and accessories

Inwave's guide contains antennas, radios and accessories from Motorola, Ericsson, Ritron and Maxon. Inwave carries more than 3,500 land mobile products. Orders can be faxed around-the-clock or phoned in on the toll-free phone number. Products are shipped 24 hours after an order is received.

Circle (204) on Fast Fact Card

Book describes a way to build better computer systems

Business Objects: Re-engineering for Re-Use by Chris Partridge is a 400-page paperback that describes, step-by-step, a systematic method for re-engineering the business entities embedded in current computer systems into general, re-usable, business objects. This **Butterworth-Heinemann** book does not cover technology or computer languages but rather paradigms, the way users see and think about what information stored in computers represents.

Circle (205) on Fast Fact Card

Publication details tutorial and offers reference for CAD system

Butterworth-Heinemann's book *Inside OrCAD* contains an overview and introduction to modern schematic drafting, with hands-on exercises intended to help the reader master the use of OrCAD. This 408-page paperback is written by Chris Schroeder and includes a disk, which contains a parts library for the tutorial exercises. A series of appendices provide tips, techniques and information about linking OrCAD to other computer-aided design and computer-aided engineering tools.

Circle (206) on Fast Fact Card

Brochure highlights products for two-way communication

Comtelco's 16-page purchasing guide features mobile, base station and marine antennas, and accessories. The catalog contains complete specifications and photos, as well as order and warranty information. A toll free phone number is available to order.

Circle (207) on Fast Fact Card

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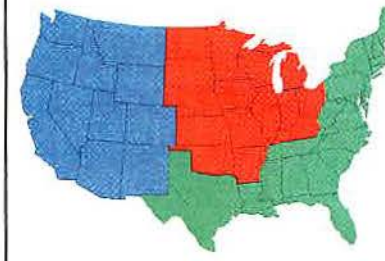

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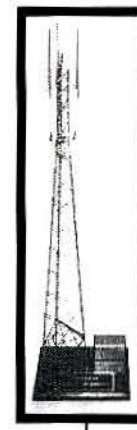

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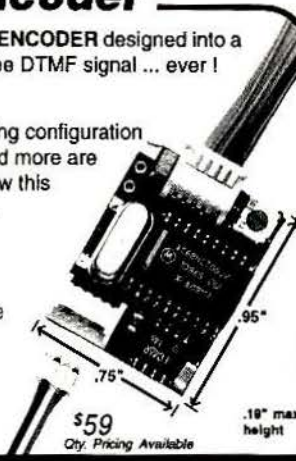

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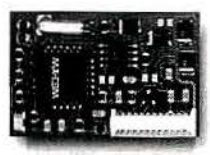

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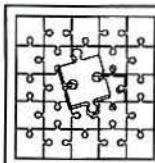

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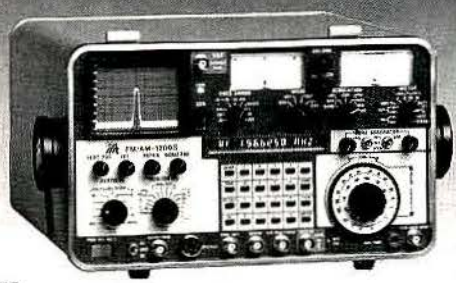

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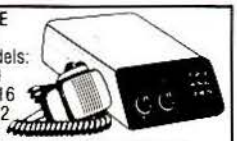

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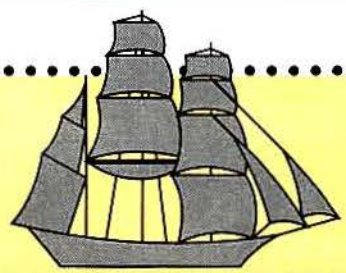

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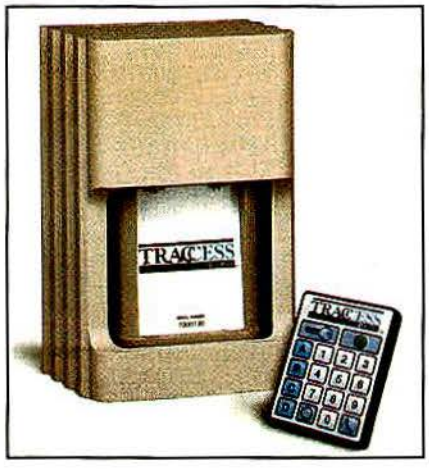
continued from page 98

Average reading meter measures analog, digital systems' RF power

Bird Electronic's Advanced Power Measurement Thruline wattmeter APM-16 measures RF power in both digital and analog systems. The compact, portable instrument handles conventional/trunked radio, paging, PCS, cellular, ISM, aviation, broadcast and military frequencies. Plug-in elements allow measurement of 100mW to 10kW at 450MHz to 2.3GHz for complex digital as well as analog RF signals.

Circle (432) on Fast Fact Card

Access management system uses electronic 'key' to ensure security



TRACcess key and electronic access management system allows companies to manage access to multiple and remote cell transmitter and PCS sites. The unit from **Supra Products** combines mechanical key control, electronic access control and access activity tracking in a stand-alone system. The central component of the system is the TRACkey, a pager-size electronic "key" that records its own access activity by location, date and time and can be programmed to expire at management-defined intervals. The information can be transmitted to a PC over any DTMF phone. Because site access varies, Supra manufactures a TRAC-box for leased sites, TRAC-Vault to store keys and access cards and TRAC-Padlock for gated areas.

Circle (433) on Fast Fact Card

System access monitor uses display permanently mounted in a vehicle

The ZK-SAM/DX system access monitor allows cellular operators to view the operation of their system using a display module that can be permanently mounted in a vehicle. The processor module is separate from the display module and is small enough to mount on the firewall or under the dash of most vehicles. The two modules are connected via a standard parallel cable, allowing easy customization. The unit from **ZK Celltest** can display and store information such as the identification of strongest control channels and voice channels, plus their respective signal strengths. A and/or B systems can be displayed and compared, and the unit will measure TDMA and analog channels. Call handoffs are displayed along with adjacent channel interference, which is identified and logged. The monitor can be equipped with an optional, integrated GPS receiver.

Circle (434) on Fast Fact Card

Mobile packet modem combines data, radio in a single package

Motorola Land Mobile Products Sector's VRM 600 is a mobile packet radio modem that contains both a data modem and a radio in a compact package. The unit, designed for use on Motorola Private DataTAC networks, provides the wireless connection between in-vehicle data terminals and an organization's host computer. It offers expanded device alternatives, such as third-party terminals and laptop computers supporting RS-232 connections. Inbound channel access is controlled by the Slotted Digital Sense Multiple Access protocol. This maximizes channel use by allowing the network's resources to remain available to other users. The VRM 600 offers connectivity for laptop and notebook computers, mobile data terminals and Global Positioning System (GPS) receivers. It also offers a GPS interface option. The rugged design exceeds EIA specifications and withstands harsh mobile operating conditions.

Circle (435) on Fast Fact Card

Paging antenna combines three omnidirectionals in one radome

Celwave's Combi antenna for paging applications offers three 5.5dBd omnidirectional antennas in one 12.6-foot radome. The VSWR is 1.3:1 from 935MHz to 960MHz and 1.5:1 from 890MHz to 935MHz. The antenna has more than 40dB of isolation between sections and can handle 400W of power. This allows the antenna to handle a 500W paging transmitter with a cable run of 1dB or greater.

Circle (436) on Fast Fact Card

Upgrade kit adds NiMH features to NiCd maintenance systems

JBro Batteries' NiMH upgrade kit for Telepower NiCd battery maintenance systems adds the capability to condition and analyze NiMH replacements. The kit uses special software algorithms unique to NiMH battery formats.

Circle (437) on Fast Fact Card

Base-loaded mobile antennas get 3dB gain with $^5/_8$-wave whip

Comtelco Industries' base-loaded mobile antennas for 132MHz–280MHz achieve 3dB gain with a $^5/_8$-wave whip and a base-loaded matching coil. Power handling capacity is 200W. The base is triple-plated chrome brass with a large insert-molded, low-loss coil form and a spring-loaded, gold-plated contact. O-ring seals and overlap construction prevent moisture infiltration. All antennas mate with a TAD/NMO mount.

Circle (438) on Fast Fact Card

Ad index/hot line

Company	Page Number	Fast Fact Number	Advertiser Hotline
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Advanced Videotech	73	60	800-233-0013
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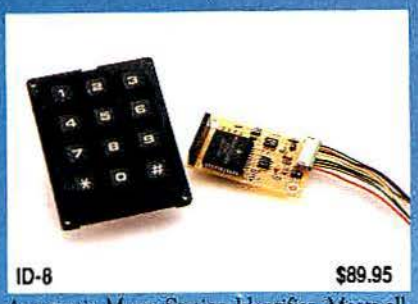

ID-8 $89.95

Automatic Morse Station Identifier. Meets all FCC ID Requirements. Fully field programmable with included keypad. 1.85" x 1.12" x .35"

TE-64 $79.95

Self-contained Encoder, Rotary Dial Selection. Great for the Benchtop. 5.25" x 3.3" x 1.7"

CC-1/CR-1 $49.95 each

Surface Mount Component Kits for repairing SMT circuits. CC-1 for capacitors/CR-1 for resistors.

PE-1000 $224.95

Desktop Paging Encoder. Two-tone sequential, other formats available. 7.5" x 7.8" x 2.7"

PE-2P $54.95

Two-tone Sequential Encoder. Sub-assembly mounts inside radio or other enclosure. Multiple call capability. 1.25" x 2.0" x .4"

SD-1000 $59.95

Two-tone Sequential Decoder. Programmable unit provides switched outputs from two-tone paging calls. 1.25" x 2.0" x .4"

DTD-1 $59.95

Single Function DTMF Decoder. Provides switch outputs via DTMF. 1.25" x 2.0" x .4"

PE-4/PE-15 $99.95

Multiple Call POCSAG (RPC-1) Paging Encoders. Where direct control of local area paging is desired. 1.78" x 1.03" x .35"

DCS-23 $59.95

Digital Coded Squelch Encoder-Decoder. Programmable to all codes. 1.36" x 1.18" x .25"

TS-32P $57.95

Programmable CTCSS Encoder-Decoder. Tone squelch for any FM transceiver. 1.25" x 2.0" x .4"

TS-64 $64.95

Sub-miniature Programmable CTCSS Encoder-Decoder. 1.7" x .78" x .25"

SS-32SMP $27.95

Sub-miniature CTCSS Encoder. Jumper programmable. .53" x 1.0" x .16"

SS-32PA $28.95

Programmable CTCSS Encoder. Custom tones or audible tones also available. .9" x 1.3" x .4"

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